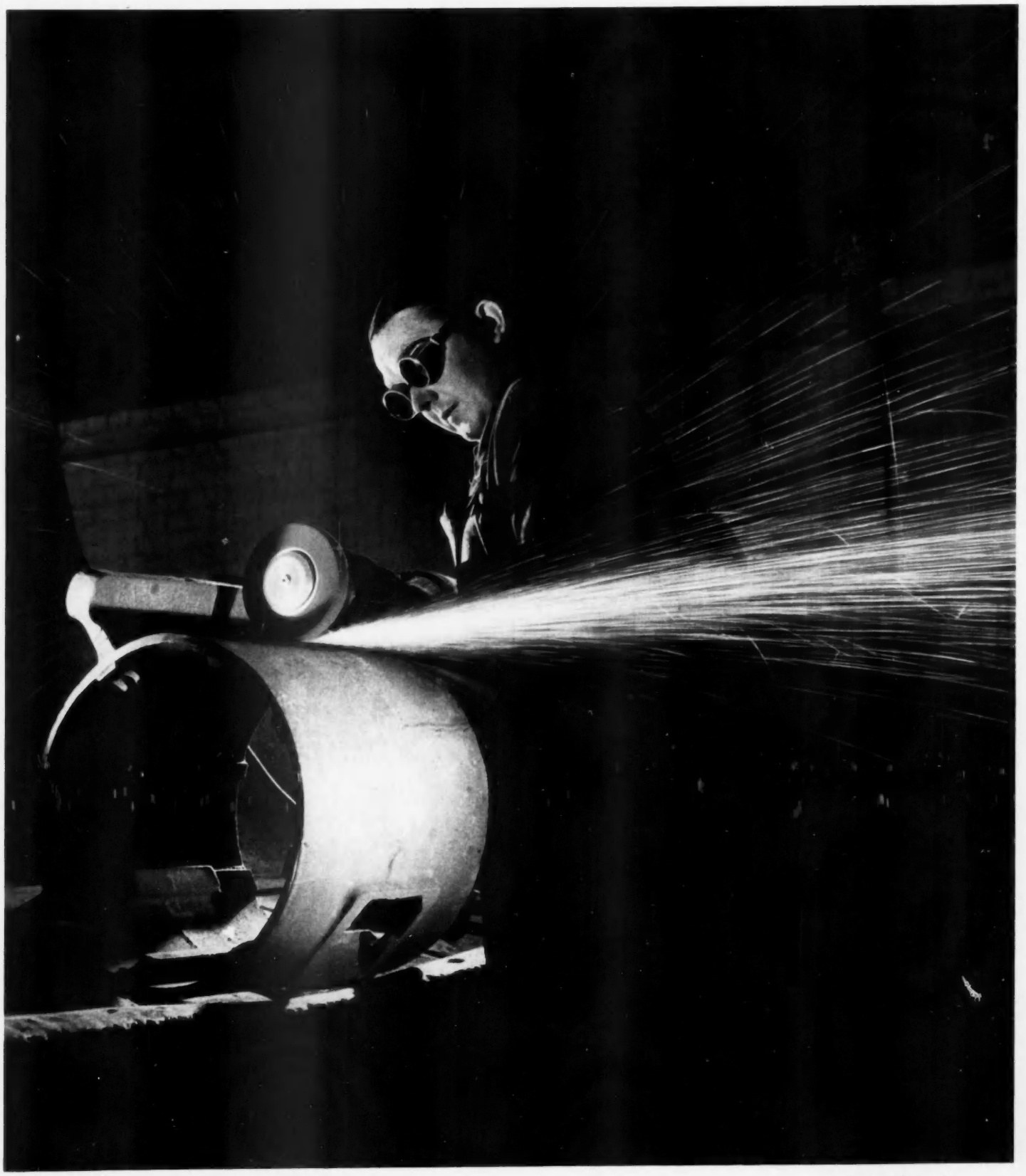
ENGINEERING 26-4-57

ENGINEERING

An Illustrated Weekly Journal

35 & 36 BEDFORD STREET, STRAND, LONDON, W.C.2 - - TELEPHONE: TEMPLE BAR 3663

Vol. 183 No. 4755 *LONDON, FRIDAY, APRIL* 26, 1957 PRICE 2s.



GRINDING A STEEL CASTING

Nurnberg photograph for ENGINEERING

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Published every Friday by Engineering Limited, 35 & 36 *Bedford Street, Strand, London, W.C.*2
TELEGRAPHIC ADDRESS *Engineering, Lesquare, London* TELEPHONE *Temple Bar* 3663

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Subscription Rates for 12 *months, Inland and Abroad* £5 10*s.*, *Canada* £5 5*s. Subscriptions for periods of less than* 12 *months are based on the price of a single copy including postage* (2*s.* 3*d.*)

THE CORN IS GREEN

WALES possesses two great natural resources—coal and water—but it is only since demand began to outstrip supply that their economic importance has been properly appreciated. That coal is a dwindling asset is now generally accepted, but that water, though a renewable asset, is not an unlimited one is less widely recognised. For coal as a generator of electrical energy, substitutes have been found in oil and in nuclear reactors. For water no substitute is in sight. The dry spell of 1955-56 brought home to many authorities throughout Great Britain the inadequacy of their existing water supplies. These shortages were attributable not so much to a deficiency in the amount of rainfall as to an insufficiency in the storage capacity to cope with the rapidly expanding demand for water. Water supplies to certain English cities have been provided by Wales—while the development of Wales has been neglected.

Part of the increase in water consumption is accounted for by the normal growth in population. It is accompanied by a higher standard of hygiene and sanitation in both rural and urban districts, but is quite dwarfed by the spectacular rise in industrial requirements. And there is evidence that agricultural yields could be substantially improved by summer irrigation to the extent of 250,000 gallons per acre in a dry season. The average rainfall over the British Isles is equivalent to about 2,000 gallons of water per head of the population per day. Allowing for loss by evaporation, this is about 15 times the total present consumption. A major portion of the water is returned by rivers to the sea, but some is retained as underground storage water (as in the London basin) and some is impounded in surface reservoirs. As the geological structure of Wales precludes underground storage, the Principality is primarily dependent for its water supplies on surface reservoirs and rivers. Approximately three-tenths out of an estimated total of 200,000 million gallons storage capacity for England and Wales is located in Wales and, of this, 63 per cent. is owned by English authorities.

Diversion of Welsh water to industrially over-congested areas beyond the boundaries of Wales on this scale is clearly prejudicial to the economic development of Wales, particularly to that of the industrially underdeveloped counties of Montgomery, Radnor and Denbigh, in which the reservoirs supplying Liverpool, Birmingham and Birkenhead with water are situated. No payment is made in respect of the water drawn from these reservoirs.

Considerations such as these have occasioned the widespread opposition by responsible Welsh interests to the decision of the Liverpool Corporation to seek Parliamentary permission to augment its existing water supply by flooding the Tryweryn Valley in Merioneth at an estimated cost of £20,000,000. A recently published memorandum by the Welsh Economic Development Council examines the position. The memorandum urges that, before sanction is given for further encroachment by English authorities on the water resources of Wales, steps should be taken to co-ordinate the often conflicting requirements of separate water undertakings throughout Wales and to work out plans whereby the Welsh water potential could be devoted primarily to benefiting agriculture and stimulating industrial expansion within Wales. For this purpose it is proposed to set up a Welsh Water Resources Council, to include members from all the Welsh water authorities as well as representatives from agriculture and industry. The Minister for Welsh Affairs has decided to have a survey made of the water resources of Wales and to appoint a committee to advise him on matters relating to the conservation and utilisation of water in Wales.

Perhaps the most cogent reason adduced for resisting the Tryweryn Valley Scheme is based on a recommendation of the Barlow Report. The population of Liverpool is nearly three times the generally agreed optimum figure of 300,000 inhabitants for any single town, and the fact that its population has declined slightly since 1951 makes it evident that the bulk of this extra water is intended for industrial purposes. If this implied industrial development were to be resited closer to the source of the water, the cost of its exploitation would be materially reduced and a more rational and equitable distribution of industry obtained. Not only would this be in the best interests of Liverpool itself, it would strengthen the economy of the country as a whole, and immeasurably improve the economic status of Wales and particularly of those counties in North Wales where unemployment is relatively the heaviest in Britain. Industrial development could be as bright a symbol of hope to the people of those counties as the green corn was to Mr. Emlyn Williams's boy miner.

The work of the Welsh Water Resources Council, important though it undoubtedly is, can only be regarded as a preliminary step. It should be supplemented by a comprehensive scientific survey embracing all the resources that might contribute to the development of the Principality as a unit. A procedure that has proved its worth in practice was outlined by Dr. Clyde Williams, president of the Battelle Institute, in an address before a trade promotion conference last year. This institute organises teams of

specialists to conduct detailed investigations into all the factors likely to contribute to the economic development of an assigned area. These surveys are remarkably thorough, including a study of geological formations, land, mineral, water and power resources, transport facilities, location in relation to markets, technological aptitude and social habits of the prospective labour force. This is certainly a scheme that could advantageously be applied to an area of the size of Wales. Groups of experts could be provided from the members of the Welsh Economic Development Council, from the staffs of the Welsh University and technical colleges and of institutions such as the Welsh National Museum. It is the only sure foundation on which to establish industries of a suitable character, run on modern lines and backed by intensive research. It would thus ensure full employment throughout Wales. It would provide rewarding openings for Welsh graduates on their home ground and enable Wales to make its full contribution to the national prosperity.

Water Resources and the Welsh Economy. Welsh Economic Development Council, 111 Cathedral Road, Cardiff. (1s.)

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Plain Words

Why can't Diesel and electric locomotives be more like steam locomotives? Why can't they have manly lines and robust personalities?

There is little evidence so far that the newer forms of railway traction are being given decent outward shapes. They may have clean and tidy lines, and comfortable cabs for the crews, but they are not allowed to show their functional parts. The same mechanical and electrical components can be clothed in almost any way according to the taste of the designer. As a result, there is no vital and positive idiom of design. The underlying conception of design seems to be a blend of motor-car and aircraft practice. Railway officers are well aware of the inestimable loss of good-will which accompanies the gradual disappearance of the steam locomotive. Generations of men and boys have grown up with an affection for railways which has been largely due to the steam locomotive.

It is more than likely that the new locomotives will develop, in outward form, like the American motor-car—each successive design becoming more and more sensual and cheaply glamorous. The latest products of Detroit show all too plainly how readily an excitable designer could make a pair of locomotive buffers look like a certain vital statistic. This trend might impress an overworked railway officer, but it would not affect the boys who are the next generation of passengers and railway officers. Unless, of course, we are misjudging the sophistication of modern youth.

Diesel and electric locomotives give a free hand to the designers who impart "style." The designers must therefore make up their minds about the psychology and motives of their creations. Otherwise we shall have the worst of both worlds.

INDUSTRY GOES ANYWHERE

Asked why he had built his new factory in the hills of Gloucestershire, the managing director of a prosperous and expanding engineering concern answered in all seriousness: "Because my wife wanted to live in the Cotswolds." This, perhaps, is a good illustration of what can now be done by a very wide range of industry because the technical requirements of factory location have changed. Electricity is freely available, with oil to supplement it: there is therefore no need to hug the coalfields in search of low fuel costs. Road transport, powered by economical Diesel engines, makes unnecessary the proximity of a railway line, even for quite large firms making heavy products. In-born skills were believed to be the regional attributes essential to efficient production: the expansion of medium and light industry in development areas has proved that coalminers or riveters made remarkably good capstan operators or knitting-machine minders. The girls of Fife took to textile mill work as if they were Lancashire born and bred. Operative training has made great strides in 15 years. Finally automation means, and will increasingly mean, fewer workers per unit of output and less skill on the shop floor. There are thus fewer good reasons for picking a particular site and those that remain—proximity to markets, location of raw materials, and the location of industrial techniques—are less strong than they were.

But it would be a mistake to imagine that when the shape of our great industrial centres was determined last century it was the presence of coal and raw materials and the access to ports or railheads which invariably decided the location of industry. The Royal Commission on the Distribution of the Industrial Population, known as the Barlow Commission, tell in their report that the cotton industry first settled in Lancashire "for no particular reason except, perhaps, that the woollen industry was already there, that foreigners were kindly received and that Manchester was not a Corporation." Other evidence was given to the Commission to the effect that a prime reason for firms moving to the London region was "the appeal of its social and recreational facilities to their wives." Perhaps the correct interpretation to put on this and our earlier mention of a wife's wishes is that women—if they are the wives of industrial V.I.P.s—exert greater influence on where a firm shall go than any planning authority or Government agency. In an excellent analysis of the factors at play, entitled *The Planning of Industrial Location*, Mr. Peter Self comments that "it cannot be assumed that the industrialist picks his site after a careful calculation of comparative costs. He may be strongly influenced by personal motives and he is very liable to make mistakes through lack of information or foresight." Yet the whole social structure of the country is affected, and the personal lives of all the people in the area affected.

Typical of 19th Century ideas on factory location—a Yorkshire woollen mill.

GOVERNMENT PLAYS DUMMY

The record of the Government in recent months suggests that in matters of industrial location they are far less influential or effective than the wives of their industrial colleagues. The Minister of Housing and Local Government, Mr. Henry Brooke, met a deputation from the London County Council, and the City Councils of Birmingham, Bristol, Glasgow, Liverpool and Newcastle-upon-Tyne to answer questions on the Government's policy of decentralising population and industry from the congested cities. The deputation told him of the local authorities' problems, mainly financial, in their attempt to use the Town Development Act, 1952. But Mr. Brooke could hold out no hope of an increase in the Exchequer grant under the Act, and did little else except offer a straight and very dead bat. Last month Lord Bilsland, formerly chairman of Scottish Industrial Estates Limited and of the executive committee of the Scottish Council (Development and Industry), chided the Government with apathy and indifference to the working of the Distribution of Industry Act, 1945. Quoting the Government's own statement that assistance for factories in development areas would be confined to only a few projects of special urgency and importance, he said that "a major Act of Parliament had, therefore, been rendered practically inoperative, without any declaration of policy about its replacement."

Statistics given by Lord Bilsland on the development areas' share of industrial building were evidence enough of the ineffectiveness of official policy. In the three years 1945-47 their share was 50 per cent., for the two succeeding years it fell to 17 per cent. and for 1954-56 it ranged from 17·3 to 18·9 per cent. The improved conditions in the development areas were due "largely to the revival of the basic industries in those areas." Lord Bilsland proposed an authoritative review from which machinery would be set up to keep the situation under control. The reply of Lord Mancroft, Parliamentary Secretary, Ministry of Defence, was lukewarm and non-committal. He could see no need for a formal review, since the Government had "nearly all the information and the power they wanted and could carry out a review from that information."

SO LITTLE PROGRESS

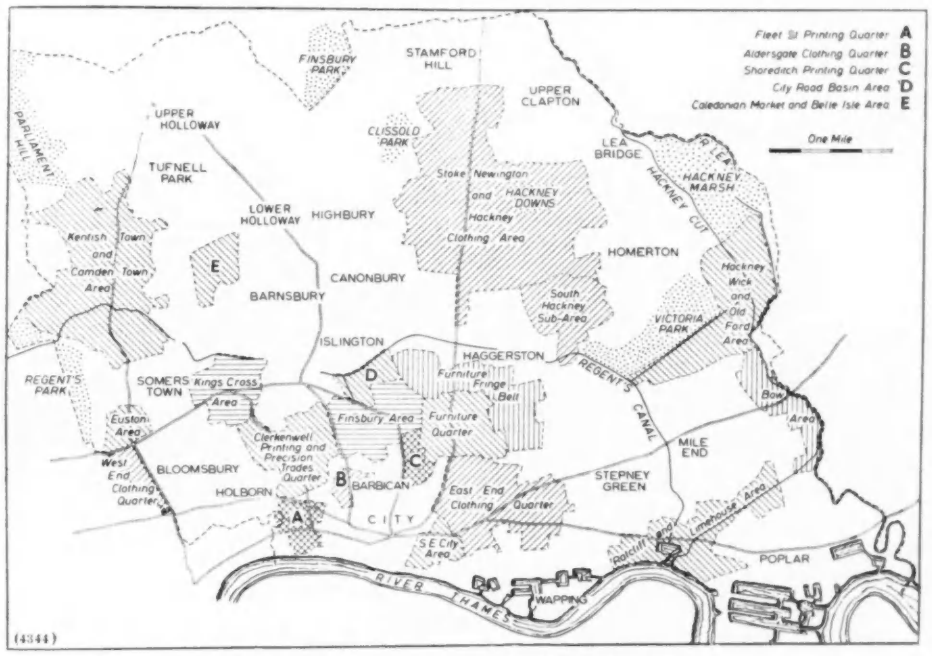
If available statistics accurately reflect the present position, very little has yet been achieved under the Distribution of Industry Act other than limited direction of the location of new factories. Even this has failed to counter the tendency of large industrial centres by the expansion of local industry and by their attractiveness as a market for companies located in less congested areas. Lord Bilsland pointed out that in 1955 the Greater London Area contained 29 per cent. of the insured population and that more than 20 per cent. of industrial building approved for the whole country between 1945 and September, 1956, was located in that area. There could be no more damning evidence

of the Government's failure to relieve congestion. Writing on the rapid expansion between the wars of the two great concentrations of Greater London and the West Midlands, Mr. Peter Self concludes that the main reason was that " these areas already contained a high proportion of the new and expanding industries." The Metropolis obtained nearly half the new factories opened in Britain in the six years up to 1937. The Barlow Commission, who reported in 1940, decided unanimously that the drift of the industrial population to the London region constituted a social, economic and strategical problem which called for immediate public action. They produced evidence that " over a period of sixteen years, Greater London and its adjacent counties attracted more than a million migrants from other parts of the country, principally the depressed areas."

TAKING WORK TO THE WORKERS

A great deal of controversy has existed on the choice of methods to relieve congestion. Many believed that if housing was provided for people in areas where space allowed the building of houses with gardens, the social evil of the sprawling large cities would be solved. That this has failed is there for all to see in the London and Birmingham suburbs, with millions travelling 5 miles or more to work each day. A near complete divorce between work and home has resulted, with all the complex social issues involved. Time which could have been available for communal activities is spent travelling, and there is a marked disintegration of community life accompanied by a parallel atrophy of family life. Long before the subject received official attention, Ebenezer Howard conceived that the only solution was to create model industrial towns, with the necessary industry to support their inhabitants and distribution facilities to provide for them. Letchworth and Welwyn were thus conceived and after a very slow start have completely vindicated the view held by Howard and his friends. New towns provide the opportunity to plan industry, housing and local amenities to secure pleasant working conditions and a high degree of integration of work and leisure without exposing the inhabitants to the noise and pollution of the older industrial centres.

It has not always been easy to convince industry that the choice of a new town site was correct from manufacturers' points of view. The success of the new town, however, is proof that this policy is practical and generally beneficial.



Traditional areas for specific trades in north-east London.

housing and planning policy is shifting to " a greater attention to slum clearance and central redevelopment, the urgency of providing for the 'overspills' of people and industry from the congested towns becomes greater than ever." On these grounds new places should currently be planned for 2 million people, and the new towns can take only another 350,000. The deputation of local authorities to the Minister of Housing quoted earlier could well have pointed out that the necessary expenditure on development of this kind is far less than it appears. The cost of overcrowding, in terms of lost working hours, congested public services, fatigue, pollution and ill-health is immense. The crucial point of the failure to accelerate new town construction is that industrial expansion takes place elsewhere, and tends to do so in an unplanned manner despite the powers of central government and local authorities to regulate and limit the growth of existing industrial areas. No balance sheet has been drawn up of the true cost of new town construction, setting off against the vast expenditure of capital required the equally vast savings that result and the gain in industrial efficiency and the well being of the people.

WILL INDUSTRY MOVE OUT?

Some of the difficulties involved in securing the movement of industry out of congested areas are illustrated in a survey of industry in inner London, written by Mr. D. L. Munby. His report, *Industry and Planning in Stepney*, 1951, revealed the existence of small districts with a preponderance of plants engaged in similar trades, as shown on the map reproduced on this page. For example, the area he defined as the East End Clothing Quarter has 17,000 clothing workers out of a total of 25,000; the Fleet Street Printing Quarter has 9,000 of its 9,500 workers in printing works. As Mr. J. E. Martin has observed " The degree of specialisation is often remarkable. . . . Plant commonly concentrate to gain economies from interdependence or from contacts with proximate purchasers. Such concentrations are particularly difficult to move and may be among the least hopeful sources of candidates for new and expanded towns." The apparent thriving of some industries on slum premises raises important social problems which, in all probability, can be solved only through the compulsory action of slum clearance schemes. At the same time it would be wrong to suppose that all commercial and industrial undertakings in large cities would steadfastly refuse to move out of them if they could do so at relatively little capital cost, or if they could be shown that the savings possible in new locations made the move worthwhile. Many would move gladly and quickly if they could afford it.

Much remains to be done to provide convincing evidence of the advantages of a move. Government and local authority staffs concerned with industry location and town planning tend to lack the industrial background and experience to appreciate industry's point of view and therefore fail to persuade in many cases when the people concerned would be amenable to well arranged factual evidence. There is obviously a need to provide for the specific needs of industry itself. As Peter Self points out, " areas zoned for industry must have good access and transport facilities, and sufficient land in total must be provided to meet foreseeable industrial requirements." But, as mentioned in the opening paragraphs, there is now a considerable range of industry which has no unmovable roots. In part this is the product of technical change, which in turn demands new environments and conditions. A small example of this is the possibility, through advances in closed circuit television, of removing out of congested areas vast amounts of records and large clerical staffs. Banks, insurance companies, large manufacturing companies' head offices could well be located miles away without impairing the accessibility of the records or the availability of the staffs for consultation for those whose place must remain at the heart of affairs. If the Ministry of Housing and other interested Government departments and local authorities improved their methods of handling what has come to be known as " non-confirming industry " there would be far less of it. If this is not possible, and the evidence so far is discouraging, the suggestion of Lord Lucas of Chilworth made recently in the House of Lords—that there should be a central authority in the shape of a Minister of Industrial Development " because at present industrial development is the plaything of various departments "—could be the best way out.

AN OUTMODED CONCEPT

Since the early 1930's it has become accepted that some measure of public control over the location of industry is both necessary and desirable. The dominant aims of Government policy have been to pump new life into distressed areas. But the conditions which prevailed between the wars have changed so radically that in 1957 there is less labour to spare in so-called development areas than in those occupied by " growth " industries. Among the main contracting industries of the 1930s—coal mining, cotton and wool textiles, shipbuilding and iron and steel—only cotton has contracted further. Coal demand and output are expanding, and have for over a decade been limited by a shortage of workers. The demand for wool textiles has grown almost as much as the demand for household appliances and electricity. The shipbuilding industry remains affected by the

neurosis developed by employers and employees alike during the years when grass grew on the slipways but the order books are loaded with five years' work and for the first time for several decades capital is flowing in, and new methods and techniques are making their entry together with modern plant and machinery. Of all British industries none has better prospects. Iron and steel production still lag behind demand, despite a capital expenditure of over £100 million a year.

It can well be asked, therefore, what is meant by development areas, and what is intended should take place within them. The introduction of medium and light industries, and of process industries (e.g., oil in South Wales and chemicals in Lancashire) has provided the Governments of the past 25 years with greater successes than any other of their actions in the field of planned location of industry. In the case of Lancashire the development of shipbuilding and engineering has been such that redundant cotton workers have been readily absorbed. The problem now is to assess when weak spots will develop—if we manage to catch up with demand and to mechanise sufficiently to manage with available manpower. No one can afford to discard entirely the lessons of the past, and for this reason the Government and local authorities must continue to assist the diversification of industrial activities in development areas. But what they do will have to be done against a background of manpower shortages rather than unemployment. The country is becoming increasingly dependent on exporting her wares, and the old industries have, so far, proved to their younger rivals for scarce resources that they can sell overseas even better.

This is not to belittle the achievements of the Government's industrial estate policy. Team Valley on Tyneside, Hillington, near Glasgow, Treforest in South Wales and Maryport in Cumberland have done very well. The current great efforts that are being made under the general direction of Lord Chandos in Northern Ireland also look like being successful. It is true that the Government appreciated the changing nature of the problem, and emphasised that their policy is to steer industry to all districts where there are unused reserves of labour, and not simply to the development areas. But this approach could lead to endless vacillations as the emphasis changes with fluctuations in the performance of particular industries. The sudden reversal of fortunes in motor vehicles is a case in point. It will be hard to assess the underlying meaning of these fluctuations.

PLANNING FOR DISPERSAL

The extent of the problem of congestion and overcrowding in the main cities of Britain, and of the continued growth of congestion and overcrowding, is far greater than is generally realised or admitted. A recent attempt to measure the cost of air pollution, evaluated at £250 million a year, is only one piece of evidence of the fabulous price we have to pay. London Transport's recent survey of Londoners' travel habits, based on interviews with nearly 17,000 people, revealed that the 550,000 cars, 170,000 motor cycles and scooters and 1½ million cycles owned in the greater London area transport only 9 per cent. of all those who work in the central area. The prospect of increased motor vehicle ownership is too appalling to be contemplated. The problem of congestion is of monumental dimensions and the time cannot be far off when private vehicles will be excluded from the centre. Another fact uncovered by the survey, that the average time taken by "suburbanites" to travel to the central area is 56 minutes, with an additional 4 minutes' walk to bus stop or Underground station. Thus, on an average, Londoners take two hours to commute to their place of work. There could be few greater indictments of industrial and commercial centralisation.

The planner's main task is therefore quite clear. The dispersal of industry from congested areas is quite as important as attracting new industry to the right places and far more difficult. Employment in the congested areas must be reduced for, unless it is, the displacement of people will only result in even longer journeys to work.

A survey, carried out by the London Chamber of Commerce under the sponsorship of the London County Council, revealed that about one-quarter of the 1,162 concerns surveyed either wanted to move to a new site or would consider doing so. Most of them gave as their reason the congestion of their premises or the shortage of female labour. A number of other surveys have yielded similar results. There is no doubt whatever that, given encouragement and some assistance, quite enough concerns would leave the congested areas to provide the necessary elbow room for those remaining and to decrease the congestion to manageable levels.

Obviously, there are difficulties other than those of persuading firms to move. The availability of suitable land is one, for the country cannot afford to lower its agricultural potential. There are major social problems involved, for human beings are no easier to uproot than companies—in most cases much harder. There will be instances when the resettlement of whole communities, as for example of the printing or clothing quarters of East London described by Mr. Munby. Without doubt the construction of new towns, with social amenities and a communal life of their own, is the best long-term solution. A sufficient number of these, with well-planned housing centres and smokeless factories would change not only the face of Britain but also, fundamentally and for the better, the lives of millions of people.

Letters to the Editor

TEMPERATURES IN BRAKE DRUMS

SIR, I should like to thank Professor F. K. Bannister for his reply (ENGINEERING, April 19, page 485) to my comments on his article on "Transient Temperatures in Racing-Car Brake Drums." His answer to my first query clears up this point most satisfactorily.

With regard to the question of hot-spots on the rubbing surfaces, I can only say that, in our tests on railway wheels using rather massive brake shoes, we can observe hot-spots both with cast-iron and composition (Ferodo V.G.2) shoes and that a reasonably uniform transverse distribution of contact regions never seems to obtain in practice. The thickness of a railway-wheel rim is usually about 3 to 4 in. and I think that with this thickness there is some justification for using the semi-infinite slab theory. In view of these comments, I still believe that the limited area of contact between the shoe and the other rubbing surface is the main reason for the theory's under-estimation of the maximum temperature during braking.

The mechanism I envisage for the formation of hair-line cracks on brake drums is as follows. When the surface of the drum is heated by the braking action it expands and, because of the constraint due to the cooler metal of the remainder of the drum, appreciable compressive stresses are induced in the surface layers. Heating of the metal also lowers its yield stress and it is practically certain that, under severe conditions of braking, the surface layers will yield plastically and will be "upset." When the drum cools down, the "upset" surface layers contract and a tensile stress is set up in the surface.

The magnitude of this residual tensile stress will normally approach the yield stress of the surface layers of the drum and can be very appreciable. Tensile cracking can occur either as a result of simple brittle failure of the surface metal (probably at a stress raiser of some sort) or as a fatigue failure due to many repetitions of this stressing.

Yours faithfully,
B. BRIAN HUNDY.

Steel, Peech and Tozer,
Sheffield, 1.
April 20, 1957.

★ ★ ★

INTERCOOLING IN GAS TURBINES

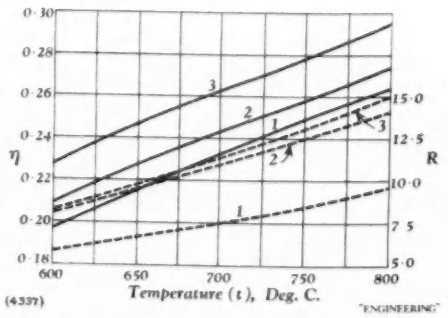
SIR, I am pleased to confirm my agreement with Dr. B. W. Martin about the effect of intercooling on the specific output of a gas turbine (referred to in his letter on page 421 of your issue of April 5). But the evaluation of this effect does not seem to have been the only purpose of his article (ENGINEERING, March 1, page 274), which in his own words, "seeks to establish, in quantitative terms, the conditions under which the thermal efficiency of the simple gas turbine is improved, reduced, or remains unchanged by the addition of intercooling to the cycle." Seen in this aspect, the manner of sharing the compression work has to play a great part in the analysis.

Now, research on the effect of intercooling, as well on efficiency as on the specific output, implies a certain amount of assumption regarding the pressure ratio of the gas turbine. I think that the most logical way is to assume the optimum pressure ratio for each cycle. Such an assumption, of course, leads to a higher pressure ratio for the cycle with intercooling than for the plain one; but it is unlikely that an intercooler would be introduced into a compressor working with a pressure ratio of 5 or 6, or, on the other hand, that an adiabatic compressor would be developed for a pressure ratio of 12 or 15. If this assumption is made, the results will be as shown on the accompanying graph, where the continuous lines give the maximum efficiency η, and the dotted lines the corresponding pressure ratio R, both as functions of temperature t at the inlet of the turbine. The calculations were made for an ideal gas with constant specific heats, the isentropic efficiency of compressor and turbine being 85 per cent., and no loss of pressure, heat or work being taken into account. The meanings of the numbers used in the graph are: 1 = plain cycle; 2 = cycle with intercooling, the compression work being shared equally between the compressors; and 3 = cycle with intercooling, the compression work being shared in the way leading to the highest efficiency.

The graph shows that the optimum pressure ratios for cycles 2 and 3 are not very different, but both of them are much higher than the corresponding values for cycle 1. At the same time, for a given value of t, the difference of efficiency is greater between cycles 3 and 2 than between cycles 2 and 1; the conclusion, which may seem unexpected, is that, among the conditions for a high efficiency, the choice of pressure in the intercooler is even more important than the intercooling itself.

Yours faithfully,
P. CHAMBADAL.

Électricité de France,
Centre des Études & Recherches,
Service Thermique,
Paris, 8e.
April 11, 1957.



Efficiency and pressure in gas turbine inlets.

Weekly Survey

Cover Picture: *Grinding a steel casting. Portable grinding machines are often used for this purpose as they are flexible tools capable of reaching areas difficult of access by other means.*

★ ★ ★

Report on the Free Trade Area

The latest economic survey by the Economic Commission for Europe has a good deal to say about the European Common Market and the Free Trade Area. This study has the merit that it gets down to cases as well as dealing in generalisations. The authors of the survey consider that motor cars, radio apparatus, certain types of clothing, rubber tyres, plate glass, porcelain and toys are the kind of articles which are likely to become more competitive within the Free Trade Area. The removal of tariff protection within the Area is expected to have most effect on industry in France and Italy and least effect in Benelux and Scandinavia. Benelux has already been through the rigours of reduced tariffs and Scandinavia is a low tariff area by European standards. It is of interest, although this is not specially developed in the report, that the dismantling of the Benelux tariffs have resulted in a much larger exchange of goods between the two countries including categories which are highly competitive. Stress is laid upon the economies of large scale production which the market is likely to offer and there is some concern expressed that there may be a movement of industry into poorer parts of the Area to take advantage of cheap labour. These are the kinds of effects which are looked for on paper and in advance of the establishment of the Free Trade Area but, in practice, they may prove to be less significant than is expected at present.

The report is naturally pre-occupied to some extent with the problem of reconciling the possibly chronic surplus position of Western Germany with the deficit position of certain other countries when it comes to clearing international balances—a problem which is at present a major pre-occupation of the European Payments Union. There is also an understandable anxiety expressed that current rates of exchange may not be suitable for the circumstances of the Free Trade Area. There is little doubt that if the Free Trade Area is to function efficiently there will have to be a good deal more flexibility in economic policy both as regards national willingness to deflate or inflate for the common good and in the adjustment of exchange rates. If these restrictions are not accepted within the Free Trade Area it would be possible for, say, Germany to take the place of the United States as a chronic creditor and the dismal history of the 1920's might be re-written on a smaller, but nevertheless, devastating scale in Western Europe in the 1960's.

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Home and Industrial

The fact that the number of units sold for industrial purposes expressed as a percentage of the total output of public supplies in Britain has remained practically constant over the past 20 years was emphasised in a paper presented at the 20th annual conference of the British Electrical Development Association. The authors of the paper—Mr. N. Axford and Mr. F. A. Hitchcock—pointed out that during the past two or three years there has been a very considerable increase in the planned development of the domestic, farming, and agricultural load. This has been largely owing to clearly defined policies, trained salesmen and carefully thought-out sales campaigns. However, the authors contended that the economy of electricity supply depends on a co-ordinated distribution system, and they held that the development of the industrial load should be approached with the same vigour as were the other fields of demand. Suggestions were made as to how the problem of increasing the consumption of electricity could be approached and the need for local staff who were well informed on supply techniques was emphasised.

It will be interesting to see what effect the authors' plea will have on the programme of future conferences. Of the five papers read at the recent conference, four were concerned with the requirements of the domestic user. This unbalance is to be expected since it has been the practice to hold separate conferences on such subjects as farming and industry. However it has been some time since a conference has given attention to selling to industry.

Speaking at the conference luncheon, Mr. V. W. Dale, who has recently retired from being director and secretary of the Electricity Development Association, remarked that it was a compliment to the conference organisers that the Electrical Engineers' Exhibition was timed to coincide with the conference. However, it is apparent that the week could be easily overcrowded from the point of view of the representatives of the electricity supply industry, and it would be a pity if representatives were drawn away from the conference by the exhibition. The papers presented, besides being a source of information, serve as a starting point for discussion. The discussion between representatives from different areas and circumstances is probably the most valuable feature of the conference.

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First Cases for Trade Courts

The Board of Trade have issued their first directive to the Registrar of Restrictive Trading Agreements, listing the initial batch of cases to appear before the restrictive practices courts. Three engineering industries are involved. Manufacturers of shell boilers are to be asked to justify the fixing of minimum prices for boilers and accessories and of standard discounts. Structural steel producers will have to do the same in respect of fixed prices for steelwork for building and of minimum and maximum prices for its erection. The third is the copper industry where it is the practice to make recommendations for selling prices and discounts of high conductivity copper semi-manufactures. Other agreements relate to bread, flour, school milk, paper, textiles, yarns and proprietary medicines.

Altogether, since the passing of the Act, 1,420 agreements have been received and 1,003 have been registered. The balance are still being studied to see whether or not they should be placed on the Register and in some cases additional information has been asked for. An analysis of the register shows that the considerable extent to which the metal and engineering industries have in the past relied on restrictive practices to ensure stable trading conditions. There are 127 agreements relating to iron and steel products, 168 to metal manufactures, 76 to electrical machinery and 141 to other machinery and transport equipment. In all, over one-third of all restrictive agreements registered relate to products of the metal and engineering industries.

The attitude the Courts will adopt is hard to anticipate. The parties to each agreement will have the opportunity to argue that it is not against the public interest and will be able to defend it on various grounds. One important ground for justification laid down in the Act is where restriction is reasonably necessary for the protection of the public in the case of goods where skill or knowledge is required. Another is where it is a defence against a large firm who themselves resort to restrictive practices, or where it is needed to negotiate on freer terms with monopoly buyers or sellers. The effects of the Courts' decisions will doubtless be far-reaching; there is no need for them to be harmful.

Uncertainties in Contracting

The next few months will see a fall in the activities of civil engineering and contracting firms on the home market. Factory building is planned on a much reduced scale and housing is unlikely to keep up at the peak levels of recent years. There is therefore an urgent need to take advantage of the heavy demand from overseas. The decision of the Dollar Export Council to send a mission to Canada to explore the possibility of increasing exports of building materials and personal visits such as that of Mr. Jim Holman of Holman Brothers, Limited, to South America are steps in the right direction. There will doubtless be room for British firms in the heavy road programme envisaged for Western Europe. Nevertheless contractors are likely to find it much more difficult to keep fully employed in 1958 than in 1956 and it is against this background that the recent merger of John Laing and Son (Holdings) Limited, and Holloway Brothers (London) Limited, should be considered.

Size is a most important factor in the successful handling of large overseas contracts. There is an increasing need for good research, development and plant facilities, and working capital requirements can be crushingly large. Laing's have a good record overseas, including a 21-storey building in Vancouver completed in 21 months and the development of a 1,200 acre industrial estate in British Columbia. They have also considerable activities throughout Southern Africa. Holloway's who are an old-established family concern, are famous for the reconstruction of the Bank of England, the Central Criminal Courts, the General Post Office and several large power stations. They have also built bridges over the Thames and seven in Iraq including three over the Tigris.

The growing emphasis on exports is illustrated by the 1956 figures of production of construction equipment published by the Federation of Manufacturers of Contractors' Plant. Restrictions on home demand due to the Government's deflationary policies led to a fall in sales from £39 million in 1955 to £36½ million whereas export sales increased from £33½ million to £39 million. There also lies the main hope of the British contracting industry. The amalgamation of Laings and Holloways will form a group large enough to undertake almost any project overseas. It is the best insurance against what appears to be the inevitable, if temporary, contraction of work in the United Kingdom.

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Electricity Price Increases

Rising costs under various headings have interfered with the North Western Electricity Board's second attempt to prevent increasing the price of electricity by expanding sales, effecting economies and improving efficiency. It has therefore been decided that as from the first normal meter reading after June 30 the price of electricity to domestic and farm consumers now charged at 5*d.* per kilowatt-hour will be increased to 5½*d.* and that of electricity charged at 0·9*d.* per kilowatt-hour to the same classes of consumer to 1*d.* The quarterly fixed charge to farm consumers will also be increased by 10 per cent. As regards industrial consumers the kilowatt charge to those taking supplies at a medium voltage will be increased by 1*s.* 9*d.* per month per kilowatt, the corresponding rise for those taking high-voltage supplies being correspondingly lower. Domestic pre-payment consumers will be charged 6½*d.* instead of 6*d.* per kilowatt-hour. As some set-off to these rises, places of worship, institutional, commercial and smaller industrial consumers are to have their tariffs standardised into four broad groups and no less than 450 forms which have hitherto been in use will disappear. The new tariffs will, however, take account of the increases to other classes of consumer, as they must bear their share of rising costs. A single exception to these increases is

that places of worship, which have hitherto been charged on a block tariff of 5½*d.*, 2¼*d.* and 1*d.* depending on the size and character of their load, are to have the number of kilowatt-hours payable at the two higher rates reduced by half. None of these changes take account of the increase in the bulk supply tariff of 10*s.* per kilowatt which was recently announced by the Central Electricity Authority and is to come into force on October 1. A further trend upward may therefore be expected before very long.

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Sheet Steel Supplies

As a result of the reviving export demand for motor vehicles and the fact that no move has yet been made to raise the minimum hire purchase deposit from the present level of 20 per cent., the motor industry has recently substantially increased its orders for sheet steel and is reported to have informed the Board of Trade that its demand for sheet steel will exceed the capacity of United Kingdom mills in the third quarter of the year. In the first two months of 1957 total deliveries of steel to the motor industry were about 30 per cent. below the level for the corresponding period of 1956 and in the absence of any revival in demand for motor vehicles it was estimated that demand for the whole of 1957 would be about 40 per cent. below the peak figure of 1955. In that year, home production of sheet steel was insufficient to meet total demand and imports amounted to 462,000 tons.

In 1956, demand for sheet steel fell substantially and if it had not been for a decline in production of about 150,000 tons due to the strike in the industry, it would have been possible virtually to eliminate imports. In practice, however, the latter totalled 166,000 tons. At the beginning of 1957, export quotas were raised since production in certain mills was falling sharply. As a result, exports in the first two months of the year increased by about 40 per cent.

Orders for sheet steel are also increasing from metal furniture and domestic appliance manufacturers and later this year, the Velindre Tin Plate Mill of the Steel Company of Wales will absorb increasing quantities of the hot rolled coil from which both sheet and tin plate are made. Total production of sheet steel for the current year is estimated at 2·35 million tons which, in the absence of new import contracts, is likely to leave some 1·9 million tons available for home consumption. This is 400,000 tons below the 1955 total. Consumers' stocks at the beginning of the year were, however, over ½ million tons and by drawing on these it may be possible to prevent any substantial rise in imports. The motor industry must hope that this will in fact be possible since the Government is unlikely to allow home demand for motor vehicles to expand to such an extent that large imports of sheet steel again become necessary.

As from next year, there should be a big improvement in the position since increased output will be available from John Summers and a further large increase in production from the Steel Company of Wales will occur the following year.

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Trade with Spain

Attention has recently been drawn, especially by official sources, to the growing opportunities which exist for United Kingdom exports in Spain. Industrial production has increased from 134 in 1946 to 240 in 1955, taking 1929-1931 as the basic year. The big jump occurred between 1950 and 1952 and until then, the figures are eloquent of Spain's relatively slow rate of industrial expansion compared with other countries, rather than of rising industrial production. Since then, however, there has been steady progress and it is of interest that in 1956 (for which 11 months figures are available only), engineering products accounted for at least 60 per cent. of this country's exports to Spain. Overall, this country is Spain's largest market and the United Kingdom ranks third (well behind the United States but only slightly behind France) as a source of Spain's imports. The trading position between this country and Spain has in fact remained very much in balance of recent years, as it has been doubtless intended that it should.

For the future, the prospects for machinery exports from this country to Spain are considered good and they are better in the medium and heavy categories than in light products. The main scope is reckoned to be in mining and public works machinery, large machine tools, steelworks, chemical plant, shipbuilding accessories and railway equipment. For the rest, where there is a reasonably economic market within Spain, that country is likely to encourage local enterprise and there may be more opportunities for many British goods if they are manufactured locally under British licence than for direct exports from Britain.

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Piping Past Suez

Early estimates of the cost of installing a new pipeline system from the Euphrates basin through Turkey to circumvent the Suez Canal suggest a figure of about £130,000 per mile and an overall cost of about £270 million. If this project is realised, it should be able to move about 1 million barrels of oil a day compared with the average capacity of 1·3 million barrels on the Canal.

This represents an increase in the cost per mile of four times that of the line across the Middle East completed in 1950 from Saudi Arabia to Sidon, and the financial problems of raising a sum of money which would cover the new project are obviously considerable. Substantial as are the oil companies' reserves, they would not be able to finance an enterprise of this size without going to the world market for money. Beyond the financial problems lie the even larger political ones. Although it would be desirable to bypass the small Middle East states completely and take the line through Turkish territory, care has to be taken to ensure that a larger wedge is not driven between the Bagdad Powers and the other Middle East states.

Once these issues are settled, there remains the technical problem of moving the oil in a 34 to 40 in. pipe over the Taurus Mountains. The technical problems at the moment loom small but they are likely to be formidable enough when the times comes.

The fact, however, that the United States is increasingly interested in Middle East oil is a good augury that the resources will be made available to carry out the project once the consortium of oil companies now operating in that area have decided that the scheme should have priority.

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Synthetic Rubber Consumption

The 1957 International Conference on Synthetic Rubber that was recently held in London drew attention to the rapid growth in the consumption of synthetic rubber in the United Kingdom in recent years. In 1954 total United Kingdom consumption amounted to only 8,693 tons, but by 1956 this figure had increased to 39,525 tons. Between 1955 and 1956 the proportion of total rubber consumption accounted for by the synthetic product rose from approximately one-tenth to one-fifth.

Nevertheless this proportion is below that of most other major rubber consuming countries and particularly the United States, where synthetic rubber in 1956 accounted for over 60 per cent. of total consumption. This has been due to the relative ease of availability of the natural product in this country and to the fact that the greater part of the synthetic rubber has had to be imported from the United States. Two new plants, those of Imperial Chemical Industries, Limited, and Monsanto Chemicals, Limited, at Newport, are, however, now in production and it is expected that next year the Fawley plant, which has a capacity of 50,000 tons of G.R-S general purpose synthetic rubber, will be in operation. The rapid growth in consumption of synthetic rubber throughout the world has been due partly to the wide range of grades which can be produced but also to a growing shortage of the natural product. It has been estimated that by 1965 total free world requirements of rubber may be as much as 4·5 million tons per annum while production of natural rubber is not expected to increase much above 2 million tons.

In this country the bulk of the synthetic product is used in motor vehicle tyres which took 28,000 tons in 1956 against only 3,000 tons in 1954. Other important uses for which consumption is increasing rapidly include footwear, conveyor belting and cables. In these fields the synthetic product has been competing directly with natural rubber but there are also a number of applications for the former for which natural rubber would not be suitable. These include important applications in the aircraft industry where the product may be required to retain its properties at low temperatures and also where the rubber will come into contact with oil.

Even where it has been necessary to import the synthetic product from the United States, the price has for the most part been competitive with that of natural rubber. Last year, for example, the price of G.R-S synthetic was about 2*s.* 1*d.* per lb., while the price of natural rubber fluctuated between 1*s.* 11¾*d.* and 3*s.* 1¼*d.* It is hoped that when large-scale production begins in this country it will be possible to reduce the price of synthetic rubber and that this will give a further impetus to its use. If in fact the long-term estimates for rubber consumption prove correct the fears of the producers of the natural product that the growth in synthetic consumption will result in a serious fall in demand for natural rubber may well prove unfounded.

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Aircraft Manoeuvres

The offer made by the Hawker Siddeley group to the shareholders of the Brush group is yet further evidence of the large aircraft constructors' desire to diversify their range of products. Hawker invested in good time in atomic energy research. This gave them a stake in the new industry but their position would have been hard to develop without a link-up with a large electrical engineering company. Brush were the last to remain "unattached," all others being part, generally in the role of senior partners, of an atomic engineering consortium.

The acquisition of Brush will give Hawker a full range of heavy electrical plant, a foothold in the railway locomotive market and a good range of water-cooled and air-cooled Diesel engines for marine, industrial and agricultural use. The business of Petters, MacLaren, Bickerton and Day, Mirrlees and National Gas and Oil Engine should prove valuable and give Hawker good claim to the title of power engineers. Their dependence on Government defence orders will be lessened and new fields open for a vigorous expansion policy.

The pattern of diversification in the aircraft industry is now well established. Earlier this month, the chairman of de Havilland, Mr. W. E. Nixon, said that his company's general policy was to maintain "the widest possible technical and geographical scope in all our activities. In the short view this policy is aimed at strength by diversification. In the long view its purpose could be expressed as preparedness, to utilise

our knowledge and resources to meet home needs and those of world markets." Their acquisition of Saunders Roe towards the end of last year added not only aircraft and helicopters to de Havilland's range but also electronic equipment, laminated wood and plastic products. A notable exception to the current trend towards diversification in the aircraft industry is Handley Page. Their chairman, Sir Frederick Handley Page, reviewed in his annual statement his company's considerable progress in research and expressed his belief that they can play a leading part in the development of long-distance supersonic aircraft. Their success in structural and aerodynamic research leading to a major advance in boundary-layer control on the surface of long-distance aircraft, thereby reducing the weight of aircraft such as the Boeing B52 strategic bomber by more than half. So far Handley Page pin their faith in aircraft and nothing else. Their success with the Victor bomber and the probability of a more advanced civil development of this aircraft being available in the early 1960's coupled with advances in laminar flow techniques, could result in a position of great strength. But in this field private ventures are difficult to finance. and Government support is becoming harder to secure.

NO-MAN'S LAND BETWEEN ENGINEER AND ACCOUNTANT

APPLYING ELECTRONIC DATA-PROCESSING TECHNIQUES

By Dudley W. Hooper, M.A., A.C.A.*

In this electronically evolutionary world of to-day the plain man finds himself in some difficulty. If he is a plain electronic engineer, should he try to appreciate the ramifications of, let us say, management accounting techniques based on actuarial evaluation of statistical data; if he is a plain accountant should he attempt to follow the higher mathematical flights of those to whom programming a computer is considerably easier than solving *The Times* crossword; or, if he is just a plain business man, where does he start?

A survey of the many books, conference proceedings, periodical articles and manufacturers' literature produced over the past year shows clearly that these are generally the three targets at which most writers and speakers aim. The National Physical Laboratory's treatise *Wages Accounting by Electronic Computer* (H.M.S.O) typifies the scientific approach to the problem, treating the progression from original data of time and work through to the pay packets as just another mathematical problem. R. G. Canning, in his *Electronic Data Processing for Business and Industry* (Wiley), emphasises that the every-day data-processing needs of industry are suitable work for electronic techniques, and writes something that the electronic specialist can appreciate as an exercise for the application of his technical knowledge. George Kozmetsky and Paul Kircher, in their *Electronic Computers and Management Control* (McGraw-Hill), attempt to review, for general reading by the plain man, both the technique and its application.

Any one asking which is the right approach would probably receive the answer "it all depends." But there is one thing certain—a need for much greater understanding between the electronic specialist on the one hand and the management-user on the other. Both are attempting to approach common problems from different standpoints, to meet with mutual understanding in the middle field of computer technology.

This difference of approach is typified by the development of electronic data-processing equipment: on the one hand downwards from the universal automatic electronic digital computer, and on the other hand upwards from orthodox punched card equipment.

And that is why, of the three, I prefer Kozmetsky and Kircher. While they state frankly in their preface that their book is written primarily for the business executive, it would not hurt any engineer to absorb the difficulties apparent on careful reading of management requirements.

But in this middle field, somewhere between clerical data-processing as a simple routine job, and the pure mathematical or scientific computation, computer techniques can and are being used to give management a service of effective information that was not previously available, or was only available at great cost and after such lapse of time as nullified its worth. Further, they give management an opportunity to integrate all requirements from one initial recording of basic data and, while the complexity of calculation in normal management accounting is very slight, the volume of processing to be done on any one individual item of information—when expressed in mathematical terminology—can produce a formula of formidable length. Both of the American books emphasise, rightly, the difficulty of preparing initial input, and the need for pre-organisation of input if one is to avoid elaborate equipment which itself becomes a giant sorter and little more. They also stress that from one initial record of a man's attendance, work, and materials consumed—with automatic consultation of standing data by interrogation—it is now possible to give a complete picture of production, labour and material consumption, and all related information, to guide production management. Subsequently, because the information happens to be readily available the installation can be used to compute each employee's net pay and other orthodox historical accounting requirements. The more mathematical approach, typified by the National Physical Laboratory publication, tends to ignore these other implications. It deals primarily with the need to determine the payment to be made to each employee each week. But in most concerns, as methods of processing are improved, as the need for management accounting and control techniques increases, so the mere calculation of net wages becomes almost an afterthought to the main operation—establishment of labour costs, quantative labour statistics and production control data.

So it is apparent that the accountant (and by this I mean the management accountant in industry providing a service of information to management) is now becoming almost a systems engineer. There is no particular mystery about computers, there is no magic; what is needed is sound appraisal and a good systems job. But it is on this point, where systems appraisal ends and programming begins, that there is a great deal of confusion and lack of definition. Much of what is normally termed "programming" in the field of electronic data-processing is nothing more or less than a first-class organisation and methods flow-chart, showing precisely what happens to each piece of data within the computation process, expressed in plain English; admittedly, this requires some understanding of the capabilities and limitations of the machine, but no more than that. Only when this has been done, and linked with a similar preliminary flow-chart for the translation of the original event into the medium in which the computer can operate, can true programming, or coding into machine language, commence. Even Canning himself is confused on this point as in one place he follows this concept, whereas in another he clearly from the context is referring to the complete appraisal as a part of programming.

The reason for this confusion of thought is not hard to find. The scientific or mathematical problem, as presented to the programmer, is already in arithmetical form. The analysis of the problem, its rearrangement to give the most economic working, are arithmetical jobs for which the mathematician entrusted with the coding is eminently suited. The engineer naturally regards the whole as part of the programming operation. But in clerical data-processing, the analysis of the problem, its economic rearrangement and its planning are organisational jobs. Not until the problem has been shaped so that it can be expressed arithmetically can true programming start.

Both of the American books are helpful in giving a clear picture of what "integration" means, and therefore what service a computer can give to management; equally valuable, they give the scientist and mathematician a clear concept of the sort of problem they are up against when applying a mathematical tool to the exercise of clerical judgment. But both books lead one again and again to the question how much should management know about electronic techniques and how much should the engineer know about management techniques?

There is then, clearly, a need for an integration of interest: a means whereby management, control specialists, production engineers, accountants, designers, statisticians, technicians and engineers can work as a team in evolving data-processing installations, can exchange information, can work towards clearer understanding of each other's problems and, perhaps most important of all, can establish a personal feeling of trust in each other's appreciation of their own problems.

None of the authors suggests how this might be done or indeed really faces up to the problem. There are in this country many conferences sponsored by professional bodies to which representatives of other professions are invited; professional bodies in different spheres of activity exchange information and consult, at council level, on common problems affecting their professions. The need is more for the common man to be able to meet his opposite number—the ordinary specialists in each field to rub shoulders with, to argue with, and to discuss particular applications and problems with each other. It is in this field that there is undoubtedly room for some organisation of individuals from all types of experience and qualification but with a common interest in the design, manufacture and use of electronic computers and data-processing equipment. I purposely say individuals. While managing councils and committees undoubtedly have a great part to play in this field by correlating their activities and interest, it is only at the level where the ordinary individuals sit round the table in group study and hammer out their differences that real understanding of the problems on both sides will be achieved.

And what problems there are—in some cases partly because of this lack of mutual understanding and appreciation. Electronic techniques are being developed, computers are being evolved to be more reliable, more compact, more efficient, more economic. But the translation of information into the computer medium, the organisation of related processes, the absorption of a computer into the day-by-day operation of a business—these are some of the problems neglected by engineer and manufacturer. It is still true that the larger proportion of the work involved in devising an electronic data-processing procedure lies in the simple organisation of the job and a very much smaller proportion in the method of computing it. We are still far too dependent on the mechanical and electro-mechanical devices which at the present time have of necessity to be associated with an electronic tool before that tool can be effectively operated; here surely is a problem which can only be resolved by clear understanding by the technician and designer of the user's needs.

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BUYING FOR THE WORKS

FORTHCOMING FACTORY EQUIPMENT EXHIBITION

Everything nowadays seems to be either the smallest or the largest of its type, and the phrase is becoming quite monotonous. It is nevertheless true that the fifth Factory Equipment Exhibition, to be held at Earl's Court, London, from April 29 to May 4, is the largest of the series so far. Last year there were 250 exhibitors—this year over 300 are taking part. Like the recent Electrical Engineers' Exhibition, this is another example of the popularity of the specialised type of display shown in recent years, where those concerned with a particular facet of engineering can go to see in one place plant of the types that interest them.

For the efficient running of every factory there are a tremendous number of "accessories" required. It is not just a simple matter nowadays of standing men around a bench, to produce with hammer, chisel and file some given item, there are all the associated services required—adequate heating, lighting and ventilating, the handling of parts coming into the factory, within the factory and preparing them for dispatch. One of the major costs in times past has been that of moving parts from one place to another inside the building itself, and therefore it is natural that mechanical aids should have been introduced to speed and cheapen the process. At the exhibition there will be many examples of fork trucks and conveyors operated electrically, hydraulically or from an internal combustion engine. Other exhibits range from large boiler plant for space heating, down to a slot machine which, for the convenience of visitors, allows five minutes use of an electric razor for 6*d*.

The exhibition is to be opened by the Rt. Hon. Iain McLeod, Minister of Labour and National Service, on April 29. While it is in progress, the British Productivity Council are holding a two-day conference on organisation and methods (April 30 and May 1), and on May 2 are presenting four studies on the use of films in industry. Many well-known people from industry are taking part at this conference. On April 29, the Incorporated Plant Engineers are holding a meeting when a paper will be presented, "An Engineer Looks Forward—Modern Trends in Factory Design and Equipment," by Mr. E. C. Stevens, vice-president of the I.P.E., and the Institute of Materials Handling are holding a two-day conference on May 3 and 4. The title of this naturally enough is "Greater Efficiency in Industry" and papers dealing with planning, handling, transportation, storage and distribution will be presented. The exhibition is once again sponsored by the *Factory Equipment News* and the *Factory Manager*.

As last year, Shell-Mex and B.P. Limited have arranged a combined display of oil-burning equipment, covering a very wide range of plant, in which 23 manufacturers are taking part. The company's portion of the stand will be used as a reception point for the Oil Fuel Centre, and as a meeting place where oil-firing problems can be discussed. Among the plant demonstrated at this combined stand will be units for air heating, with outputs from 50,000 to 600,000 B.Th.U. per hour and a small unit designed especially for home use. A pressure-jet oil burner for shell boilers was first shown last year at the exhibition, and again makes its appearance. Most of the burners are arranged for manual, semi-automatic or fully automatic control, to suit whatever system appears best to the factory owner. The largest burner made by one of the companies is for 19,500,000 B.Th.U. per hour. There are models to accommodate nearly all grades of oil fuel, certainly up to 1,000 seconds Redwood No. 1. Some of the burners are fitted with automatic self-proportioning equipment to control the heat output.

For those firms and for those processes for which a supply of town's gas is not easily available, bulk propane installations can be made and examples will be shown of the smaller tanks of 100 gallon and 75 gallon capacity. The use of "liquid gas" in this way is becoming very much more popular, since it is at present fairly readily available from the oil companies. Packaged boilers for heating are again in evidence and are to be shown by several firms. For these boilers, there are also displays of control equipment and accessories such as level switches, smoke density indicators and the like. Apart from the convector type of air heater fired by oil, there are also radiant gas panels on display, both for space heating and for canteen equipment.

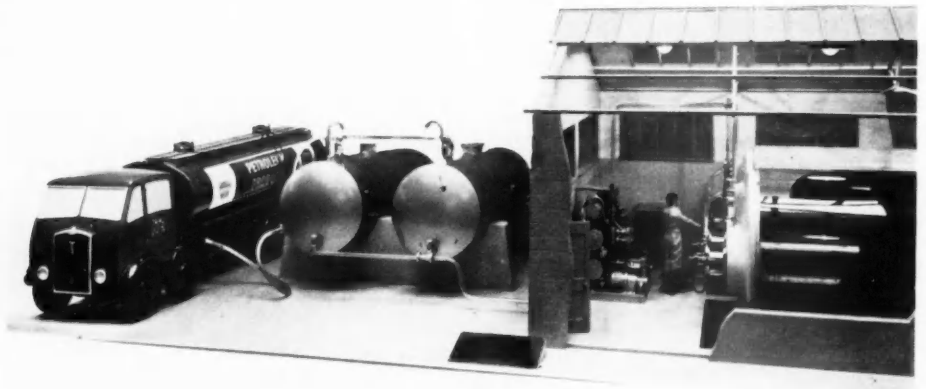
As was mentioned earlier, many types of fork truck will be on display. These include battery-operated vehicles with lifts of two tons, together with conversions for utilising them as cranes. Indeed, one firm is announcing that they have over 100 specialised attachments for handling different materials. Also there are platform trucks, designed for handling the smaller items, and pallet trucks—a result of the enormous growth in factories of the use of pallet packing and storage. For handling cases up to 100 tons there will be shown some "skates," and for general use in the factory there are many trolleys and trailers, together with power tractors for moving them. For gaining access to awkward positions inside and outside the factory for maintenance purposes, there are different types of working platform, one of which is mounted on an electric truck for reaching up to about 30 ft.; another is mounted on a Land Rover vehicle or its equivalent. The latter has a maximum working height of 26 ft. and the vehicle below it can still be used as a workshop.

In the modern factory conveyors play no small part in the handling of the smaller items, and some that are not so small. One firm will be showing packaged conveyors designed for permanent or portable installations in warehouses or factories. Wheel and roller gravity types will be on show, in addition to power-driven units which include inter-floor models.

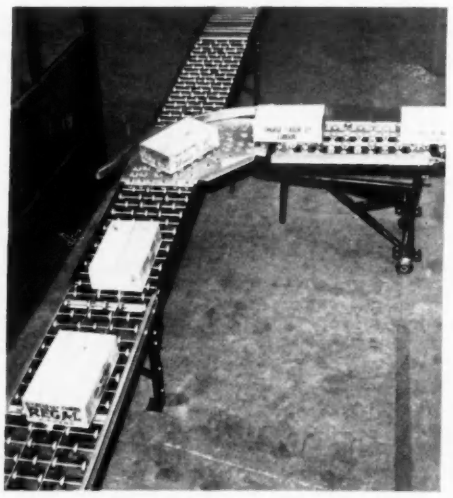
Storage is a problem in every factory, particularly of the smaller parts, and a very wide variety of bins and containers will be put forward for selection. Other equipment that can well be classed as materials handling includes such items as labelling machines and, by no means of least importance, automatic weighing machines, hopper weighers and platform scales. Some of these weighing machines are suitable for inclusion directly in a flow line and weigh the part as it passes. Communication within the factory is another necessary item of modern equipment. One system has alternatively a loudspeaker type of receiver or a personal earpiece which can be plugged in if desired. Two-way transistorised inter-com. sets will also make their appearance.

Another form of communication is that of the printed word, and this must be taken to include photo-copies and duplicators. Being shown for the first time in Britain is a series of dual-purpose direct printing photo copiers. These will reproduce by both the dye-line and transfer process, and the actual transparencies can be taken. From the printed word to the visual record is a natural step, and most modern production managers expect some sort of wall chart to indicate the position at any given time. At the exhibition there will be a selection of several makes and types together with card index systems for them to choose from. Inevitably in a factory there must be a certain amount of changing and re-organisation for which temporary structures will be required: for these there are several makes of slotted angle which are also capable of being used permanently.

Employee welfare is a subject that is already playing a large part, and will in the future play a much larger one, as an auxiliary service of the factory. With full employment, the choice by the worker of a factory very often depends on what can be offered outside his actual job. Canteens and recreation play a part in this appreciation and equipment is on display at Earl's Court. Clothing has often proved a source of contention as it has been very difficult to prove to workers that it is to their advantage to wear protective designs—several varieties showing how attractive even protective clothing can be—will be on display. Last, but not least, are the dangers run by continual handling of dirty parts; for this there are barrier creams.



"Factory equipment" covers all those items which smooth the working and reduce the cost. This model of an oil-fired boiler shows some of the "adjuncts" needed.



Parts and materials must be moved within the building; many can be handled by some type of conveyor—even round corners.

THE PLACE OF ENGINEERS IN CANADA'S EXPANSION

In a country with two professional engineers among its senior ministers and a dozen or so among its Members of Parliament it might be thought that the problem of the supply of scientific and technical man-power would be kept well to the front; but the extraordinary rate of expansion of the Canadian economy is creating problems in this field which, however well documented they may be, are nevertheless causing a good deal of anxiety in industry.

The way ahead for the next 25 years has now been plotted by the Royal Commission on Canada's Economic Prospects which has just completed its labours under the chairmanship of Mr. W. L. Gordon. A rise in population from 16 million in 1955 to more than 26 million is expected, with a corresponding rise in the annual gross national product from 26,000 million dols. to around 80,000 million dols. When the war ended the population of Canada was only just over 12 million and the gross national product, at to-day's prices, was about 18,000 million dols. This phenomenal expansion has been achieved by a total investment amounting to 48,000 million dols. up to 1954, which was 25 per cent. of the total gross national product for the period, much of it provided from American sources. In 1955 investment reached nearly 6,000 million dols. and in 1956 topped 7,000 million dols., with the American contribution growing at a startling rate.

MINERALS AND POWER

A large part of this investment has taken place in the mining and metallurgical industries and in the production of electric power; there is also every sign that the growth of these activities will accelerate during the next few years. The great new plant for the refining of aluminium being built by the Aluminium Company of Canada at Kitimat is nearing completion and the British Aluminium Company are now building a new plant in Quebec Province. The International Nickel Company is opening new nickel mines at Mort Lake in Manitoba, and the Government-owned Eldorado Mining and Refining Company is to enlarge its uranium mines and refining plants. A new project for the mining of low-grade iron ore at Ungava Bay in Quebec Province is being financed by American and German capital; the ore to be sintered and pelletised and stored in Greenland for shipment to the United States and Europe during the months when the St. Lawrence River is frozen. The completion of the St. Lawrence Seaway in 1959 will give a great impetus to iron-ore production as it will enable large ore ships to reach the ports on the Great Lakes. The production of copper and other non-ferrous metals and of asbestos is also expanding as is the production of timber, pulp and newsprint which contribute more than a third of the value of Canada's exports.

During the next few years secondary manufacturing industry is expected to increase its contribution to the national product and, at the same time, the proportionate contribution from agriculture will be reduced. Although there is little foreign capital in the iron and steel, food processing, textile and construction industries, most firms in the chemical, automobile, electrical and rubber industries are subsidiaries of American or British companies and this situation has given rise to some degree of disquiet in Canada. The Gordon report in fact recommended that foreign concerns doing business in Canada through subsidiaries should employ Canadian managers and technical staffs wherever possible; should do as much of their purchasing as possible in the country; should publish full financial statements of their Canadian operations and should sell an appreciable interest in their equity stock to Canadian investors and appoint a number of independent Canadians to their boards.

Abundance of water-power is generally thought to be one of Canada's outstanding natural advantages and this is true, if not to the extent that is generally considered. To-day it contributes 20 per cent. of Canada's total effective energy requirements and, by 1980, this may have risen to 25 per cent. In fact, in Ontario, the most important industrial province, when the existing schemes on the St. Lawrence and at Niagara are completed, there will be no more major sources of hydro-power remaining to be developed and future power stations will be of the thermal type like the great Richard L. Hearn station in Toronto, fired by coal or, possibly, natural gas. The Ontario Hydro Electric Commission is also building an experimental nuclear plant. On the other hand, the parts played by petroleum and natural gas are rising rapidly and between them these fuels will contribute nearly three-quarters of the total energy to be consumed by 1980. This has been made economically possible by the discoveries of the great oil and gas reserves of the prairie provinces; but their full exploitation will need an enormous investment in exploration and development, and in facilities for production, transport, refining and distribution, which may well reach a figure of the order of 25 billion dols. for the 25 year period.

The Gordon Report anticipates a continuance of the present rate of investment: that is to say, at a rate equivalent to 25 per cent. of the gross national product; but it is clear that such a level could not be achieved if the funds had to come from Canadian sources alone. In 1955 the net inflow of capital from abroad amounted to 10 per cent. of total investment and, in addition, a considerable proportion of the 52 per cent. which came from undistributed profits and depreciation allowances was foreign owned. When the latter are taken into account the net amount of foreign investment in Canada, after taking account of Canadian investment abroad, is estimated to have risen from 13 per cent. in the period 1950 to 1954 to over 25 per cent. in the three years to mid-1956. The Report makes a number of suggestions for increasing the supply of Canadian risk capital and so reducing this dependence on foreign capital.

QUALIFICATIONS COUNT

Canada's economic expansion is dependent on human as much as on financial and physical resources and this is not just a matter of the increasing size of the population as a whole. The need for professional engineers, technicians and skilled workers is growing disproportionately fast and its satisfaction is in competition with the needs of other countries and, in particular, of Canada's wealthier neighbour. According to a report published by the Department of Labour the number of engineers that will be needed during the three years 1956, 1957 and 1958 is expected to increase at an average annual rate of 11·4 per cent.; with industry leading with a requirement anticipated to rise 12·2 per cent. annually. Of the various branches of the profession, aeronautical engineering leads with an anticipated increase of 17·4 per cent., followed by mechanical with 14·4 per cent., and metallurgical with 13·4 per cent. Firms experiencing the greatest difficulties in recruiting professional engineers were those manufacturing chemical products and electrical apparatus and public utilities.

This expansion will come on top of a substantial increase in the employment of engineers during the last 25 years which has taken place at a rate three times as fast as the rate of growth of the civilian labour force itself, and which, in the case of mining and chemical engineers, was double that of engineers as a whole. At the present time over three-quarters of Canada's engineers are employed in industry, nearly a quarter of them on administrative work, and just over a third on design or research. The two principal sources of recruitment have been university graduates and immigration. The biggest factor in the increase in the number of engineering graduates has been the increase in the proportion of the school population attending university during the last decade; followed by the increase in the proportion of engineering students to total enrolments over the last 20 years which rose from 10 to 14 per cent. between 1935 and 1945 and has since risen to 17 per cent. in 1955. As a result of these changes the number of engineering graduates rose steadily (with an abnormal peak after the war due to the influx of ex-servicemen) from 400 to around 1,350 in 1955. In the current academic year over 1,800 students are expected to graduate; but the number of students registered in the engineering faculties of Canadian universities and military schools has risen to 12,273.

KEEPING THE IMMIGRANTS

The gain in the supply of engineers from immigration is a net figure, for some return to their home countries and a large number are attracted into the United States. Between 1953 and 1955 the number of engineers immigrating to Canada fell from 1,900 to 1,310; but this was offset by a slight falling off in the number emigrating to the United States, so that the net immigration total fell during the three-year period from 1,383 to 823. By far the largest number of these immigrants came from the United Kingdom. During 1956 the gross number again rose to around 1,800.

The Canadians are naturally anxious about the drain of engineers to the United States which is, to a large extent, the outcome of the vast defence research programme in that country. If a project is not advancing fast enough it is common practice for the United States Defence Department to hand out more contracts, often to firms without the personnel to carry them through. As a result there are cases where the firm concerned has set up offices in Toronto, interviewed every engineer employed on similar work in the town, and offered him several hundred dollars a year more to go to California. The attractions are obviously great, although the likelihood of permanent employment is by no means certain.

Several Canadian firms and public utilities are recruiting directly in England, some paying periodical visits to universities in this country for the purpose. No doubt those who do this are in urgent need of first class men; but it is by no means certain that the bulk of Canadian firms have need for as many graduate engineers as they seem to think. There is in Canada no tradition of evening school or part-time education of technicians such as is carried out by the technical colleges in this country and no awards such as our National Certificates so that, as a result, there are many complaints of graduate engineers doing routine work; for instance, as draughtsmen. This partly arises from the fact that many Canadian firms are subsidiaries of United States or United Kingdom companies so that the main research, development and design work is not done in Canada at all. An example is the English Electric Company which has established manufacturing facilities in Canada; but whose designs—for instance, of the very interesting reverse pump turbines for the new power station at Niagara for the Ontario Hydro-Electric Commission—are carried out at Stafford. There are, of course, exceptions among which are the aircraft companies and, in the scientific field, Canadian Industries Limited, I.C.I.'s subsidiary, and the Aluminium Company of Canada which has just built a big research laboratory at Arvida. The Ontario Hydro-Electric Commission carries out some extremely interesting research work on hydraulic flow problems at its scale-model laboratory in Toronto.

EXPANDING EDUCATION

In order to cope with the shortage of technicians proposals are being made for the establishment of more technical institutes like the Ryerson Institute of Technology in Toronto. Established by the Province of Ontario in 1948

and providing 5,000 evening courses in subjects as varied as cooking and TV production, this institute provides full-time courses for various types of engineering technicians leading to a diploma award. These three-year courses, in which eight months of each year are spent at the very well equipped institute and four months in employment, compare with the four years of the normal Canadian university course and start at approximately one year younger. There are at present nearly 1,000 students in these courses.

ACCEPTABLE QUALIFICATIONS

One of the difficulties Canadian firms have had in recruiting men from the United Kingdom with Higher National Certificates is the licensing regulations of the various provincial Associations of Professional Engineers. As in the United States, by law, no one can practise as an engineer or be fully responsible for design or other engineering work unless he is registered with one of these associations. Normally, registration is granted to graduates; but non-graduates can qualify after several years of practical work by passing an examination. Graduate membership of the main professional institutions of this country is recognised for this purpose, but the Higher National Certificate is not accepted as the basis of academic qualification for professional status as it is in this country by the institutions and men with this qualification are sometimes deterred from going to Canada for this reason. In order to provide some qualification and status for technicians, some of the Associations of Professional Engineers are proposing a grading scheme for technicians; but anxiety has been expressed by some engineers that this may result in a lowering of the status and salary levels of professional engineers, although it is difficult to see how this can be so in view of the long-term growth of demand for engineering staff of all kinds.

Opportunities for doing the highest level scientific work are still much greater in this country, and firms and universities are losing the opportunity to recruit good men who have gone to Canada on post-graduate fellowships, because of their insistence on personal interview in this country. This involves too expensive a risk for the young man who may recently have acquired a family and he is obviously tempted to cross the border into the United States where he will be received with open arms. Some arrangements for giving interviews in Canada are highly desirable if we are not to lose these potential and valuable repatriates.

In the future, openings in Canada for young and keen engineers, particularly in mining and metallurgy, construction and manufacturing, are obviously going to be very great and, however much we may regret their loss to this country, we must expect a proportion of those leaving our universities and technical colleges to emigrate. They will form in the future an important part of the Commonwealth connection and, in accordance with past experience, are likely to assist in the development of trade with this country. There is no doubt, however, that the cost of educating them, especially in view of our own desperate need to expand the output of engineers and scientists, may become a serious burden for the British tax-payer, and it is surely not entirely far-fetched to suggest that the time may come when we have to ask the Government in Ottawa to make some contribution towards it.

PLASTICS PATTERNS IN THE FOUNDRY

The introduction of plastics as materials for the manufacture of foundry patterns has opened a wide field for interesting development and the results obtained have been so successful that the future of the new materials in the pattern shop appears to be assured. For the past two years the possibilities of employing plastics patterns in iron, steel and brass foundries have been investigated and developed in the Crewe Locomotive Works by Mr. H. G. C. King and it has been found that patterns possessing considerable mechanical strength and having a surface finish at least equal to the best metal patterns can be produced. Furthermore, the cost of a plastics pattern is little more than that of the conventional wood pattern, and after using them for producing many thousands of moulds in a jolt-squeeze machine it is found that the wear on the plastics pattern is so small that it cannot be measured. No elaborate plant or equipment is necessary and, for a small outlay, a start in their manufacture can be made.

As the patterns are formed by pouring the resin mixture into open moulds, usually made from plaster, split patterns of the type readily assembled on plates for machine moulding are particularly adaptable. The master pattern must be dimensionally correct and have a clear surface, as any imperfections, even brush marks, will be reproduced on the plastics cast. After securing the master pattern to a board this is surrounded by a wooden frame and a fairly thin mix of a good grade of plaster poured into the frame. When the plaster is firm the master pattern is withdrawn, the frame removed and the plaster mould placed in an oven until thoroughly dry.

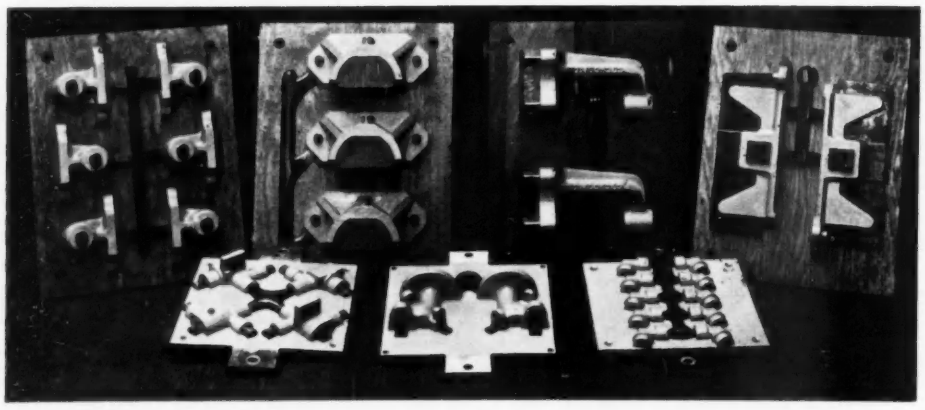
The surface of the mould which is to come into contact with the plastics material must be sealed with a releasing agent. This can be either a wax polish diluted with carbon tetrachloride or a special lacquer supplied for the purpose. Several formulae are available for making the plastics pattern from epoxy resin and these provide a range of casts having hardnesses varying from that of glass to that of a flexible material not unlike hard rubber. For foundry patterns it has been found satisfactory to utilise 100 parts of epoxy resin (supplied by the manufacturer in the form of a syrup); 75 parts of powdered calcium carbonate (which constitutes the filler); and 15 parts of a hardening agent, the addition of which transforms the syrup into a solid.

The plastics mix is poured into the plaster mould slowly and with care to avoid trapping air pockets. The casts are allowed to remain undisturbed at a temperature of 70 deg. F. for from 6 to 8 hours and are then transferred to an oven, kept at a temperature of 180 deg. F., for four hours. When cool the moulds are stripped from the plastics patterns and this should be done with care as, until the material reaches its full mechanical strength, in about 48 hours, there is a tendency to brittleness.

The application of plastics to the production of foundry patterns can be developed further by the introduction of reinforcements. These can be in the form of woven glass fibre matting for large areas or of glass fibre rovings for confined sections. Pieces of matting, and, or rovings are cut to suitable sizes and thoroughly impregnated with the resin mix. As the mould is being filled the reinforcement is built up in laminated layers, giving a finished article of great strength. This technique can be applied particularly to the manufacture of core boxes.

The carrying out of repairs to patterns and core boxes is a simple matter. In the case of breakage, the fractured surface is thoroughly cleaned and a normal resin mix used as an adhesive. Should the broken part be lost, the shape can be rebuilt by using a resin mix which has been allowed to stand until it is thick enough to be applied with a palette knife. In all cases of repair, heat treatment should follow and the rough built-up area filed and smoothed down into shape.

The illustration below shows a variety of plastics patterns fixed on metal plates and thick plywood panels. The actual attachment of the patterns to the plates is a relatively simple operation, the plastics material being readily drilled and tapped to facilitate securing by normal methods.



Cast plastics patterns fixed on metal plates and thick plywood panels. The plastics material, which is produced from an epoxy resin, a calcium carbonate filler and a hardener, is readily drilled and tapped to facilitate securing by normal methods.

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BONDED AIRCRAFT STRUCTURES

International Success of Redux Process

The extent to which the British metal-to-metal bonding process developed by Aero Research Limited, Duxford, Cambridge, has been adopted by the aircraft industries on both sides of the Atlantic, was demonstrated by the international attendance at a conference recently organised by the company on "Bonded Aircraft Structures," held at Duxford. Over 60 delegates were present from Australia, France, Germany, Holland, Northern Ireland, Spain, Sweden, and the United States, as well as from the home country.

The conference discussions were "off the record," but it can be said that the subjects covered ranged from the fundamentals of gluing through the design aspects of bonded structures, production methods and tools, the design and production of honeycomb sandwich structures, inspection techniques, Araldite epoxy resin tools, and high-temperature adhesives. On the latter subject, we learnt that research carried out at Duxford suggests that adhesives based on super-polyamides (nylon) and a phenolic resin show promise. At present, these non-brittle quick-curing adhesives have satisfactory hot-strength at the lower end of the temperature scale, 150 deg. to 250 deg. C., but a considerable advance in their heat resistance is believed to be possible. Epoxy resin adhesives, it is thought, may prove to be capable of satisfactory adhesion up to 300 deg. C. In their present state of development, brittleness accompanies a high softening point and leads to a sacrifice of some strength at normal temperatures.

Points brought out by the users of Redux-bonded aircraft structures are its superiority over riveted construction for integral fuel tanks,

and for structural use generally from the point of view of reducing stress concentrations and increasing fatigue life—the reason why, for example, this form of construction has been so extensively adopted in the Fokker Friendship feeder-liner. The use of honeycomb construction in airliners, it is thought, may provide a useful contribution to cabin noise reduction. Particularly interesting is the use made by Chance Vought Aircraft Incorporated, U.S.A., of Redux for bonding magnesium alloy in the F7U-3 Cutlass aircraft and Regulus I guided missile, on the basis of earlier experience which had shown Redux-bonded magnesium assemblies to be markedly superior in corrosion resistance to spot-welded magnesium assemblies. This is of importance for carrier-based weapons. The company state that in several years of service duty aboard aircraft carriers stationed around the world, not one structural failure, or failure due to corrosion, has been reported for the Redux-bonded assemblies in these craft. Likely future developments in the use of metal bonding in aircraft structures are the " productionising " of the gluing techniques, and the possible development of cold-setting glues, for facilitating the final assembly of major structural components.

STRESS RELIEVING TRANSFORMER LAMINATIONS

CONTINUOUS FURNACE SHOWS SAVINGS

For some years it has been the standard practice in the manufacture of transformer laminations from cold-rolled silicon-steel sheet, to stress-relieve the sheets in a lift-off furnace after the stamping operation. It is important that the stress-relieving shall not cause buckling or distortion of the sheets, and the lift-off furnace has been used because it allows the packs of laminations to be placed carefully for good heat transfer, and to be left undisturbed throughout the heating and cooling cycle. A critical examination of the process, however, carried out by Metalectric Furnaces Limited, Cornwall-road, Smethwick, 40, Staffordshire, showed that it has several disadvantages besides the obvious one of being worked on the batch principle.

It was clear, for example, that considerable difficulty is experienced when loading the furnace. The stampings vary considerably in length and width, and great skill is needed to fit the greatest possible number of stampings into the furnace, allowing for good heat transfer and avoiding distortion. Even if large numbers of stampings of the same size could be obtained, it would be undesirable to have an unbroken stack of them to the full piling height of the furnace, as heating and cooling would then be extremely slow. The heating rate could not be increased, as heat transfer is inwards from the edges of the packs; the slower the heating, therefore, the better, if distortion is to be avoided. In practice, steel spacer pieces are placed every 6 to 8 in. to separate the packs and allow some vertical heat transfer as well as the inwards transfer from the sheet edges, and this, coupled with a slow heating and cooling cycle, reduces the distortion, but it does not overcome the difficulty entirely. Moreover, steel plates have to be used to support the packs of stampings over the spacer pieces, and a considerable weight of steel is thus heated uneconomically at each cycle. To ensure complete soaking of the stampings, spacers, plates and furnace cover, it is necessary to have a cycle time of from 40 to 50 hours.

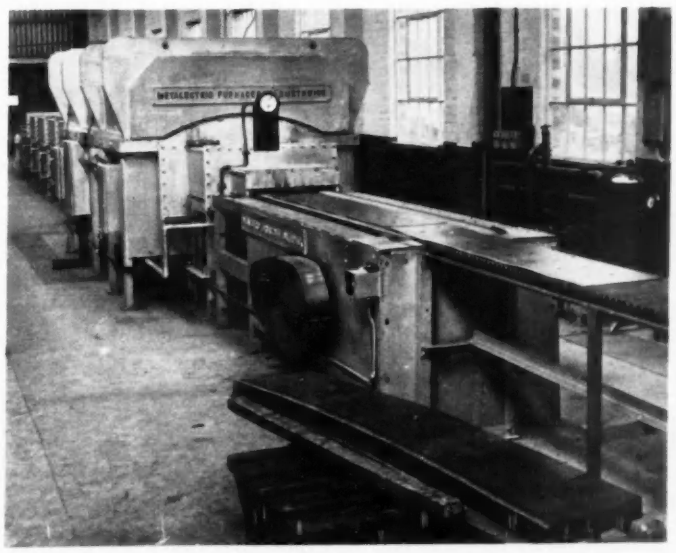
This long cycle brings further difficulties. Carbon is an undesirable impurity in electrical sheet steel, and the sheet manufacturers work to as low a carbon figure as possible; it will certainly be below 0·008 per cent. Such sheet is, of course, highly susceptible to carbon pick-up, especially when the heating period is a long one, and the furnace atmosphere must be non-carburising. Lift-off furnaces on this type of work are therefore operated with an atmosphere derived from cracked and burnt ammonia, which is not by any means the cheapest of furnace atmospheres.

ADVANTAGES OF CONTINUOUS HEAT TREATMENT

On the basis of these facts it appeared that continuous furnaces would offer at least four advantages over the lift-off type for lamination stress-relieving. It seemed obvious that the time cycle could be reduced considerably, because only small quantities of stampings would be in the heating zone, and that, as a result of the shorter heating time, a cheaper furnace atmosphere could be used. A better flow of work appeared possible because the furnace could be designed to suit the maximum width of sheet, and variations in length, so troublesome in the batch process, could be ignored. Finally, an appreciable fuel saving was likely, as there would be no spacers and steel plates to heat.

Tests were therefore carried out by Metalectric Furnaces Limited, on a furnace of the continuous type, arranged to use any industrial controlled atmosphere. By arrangement with a manufacturer of electrical equipment matched pairs of test pieces were cut from sheet, and one piece in each pair was stress-relieved in the normal way, while the other was heat treated in the continuous furnace. The samples were then tested and compared. Physically, the continuously-treated test pieces were much better than those from the batch process. In electrical tests there was less difference, but a slight advantage was disclosed in favour of the continuous process. The mean losses in watts per lb. of a large number of the batch-treated samples were 0·539, 0·536 and 0·542, while the continuous furnace gave 0·523, 0·527 and 0·526. The mean of these figures is 0·539 for the batch and 0·525 for the continuous process. These results indicated clearly that the long-cycle process and the lift-off furnace were unnecessary.

The next step was to stress-relieve sufficient stampings to build a complete transformer, in order to prove the method, and to show that the faster heating and cooling rates had no deleterious effect on the laminations, either physically or electrically. This experiment was completely successful, the laminations were flat as they left the furnace, and the furnace atmosphere used cost only one-fifth of cracked and burnt ammonia. Numbers of continuous furnaces have now been installed or are being built for this purpose by Metalectric Furnaces Limited, and experience has shown that while the total cost of stress-relieving in lift-off furnaces is between £8 and £10 per ton of laminations, the figure for the continuous furnace is £5 10*s*. to £7 10*s*. per ton.



Transformer laminations are stress-relieved in this Metalectric continuous furnace more cheaply than in the conventional lift-off furnace. Quality of product is also improved.

CONTINUOUS PROCESS IN USE

A typical furnace is shown in the accompanying illustration. It is installed at the works of the British Thomson-Houston Company, Limited, Rugby. The overall length of the furnace is 60 ft., and the heating section has two separately-controlled zones. The nickel-chromium tape elements are fitted to the sides and hearth of the chamber, and are rated at 120 kW. Normal working temperature is 820 deg. C., but the furnace is designed to operate up to 900 deg. C. The cooling section is water-jacketed, and is mounted on rollers to allow for expansion. The conveyor is 26 in. wide, to handle laminations up to 24 in. wide, and is driven through a variable speed gear, the usual belt speed being 1 ft. per minute. This gives a complete cycle from charge to discharge of one hour, compared with the 40 hours or more of the batch process. The output at this speed is 450-500 lb. per hour.

The laminations are loaded directly on to the conveyor in shallow packs, and travel through an inlet canopy designed to reduce controlled atmosphere losses, then through a vestibule which acts as a heat seal, and so to the regulated heating and soaking zones. From this point they pass through the cooling zone and then emerge through an outlet canopy on to a roller conveyor. The power consumption on this furnace is only 15·2 kWh per cwt. of work processed.

The protective atmosphere is supplied by a " Hi-nitrogen " plant made by the Incandescent Heat Company, Limited, which produces 1,000 cub. ft. of nitrogen per hour. Air is drawn in and mixed with sufficient fuel (in this case town gas), to give complete combustion and thus remove the free oxygen in the air. The products of combustion are then bubbled through monoethanolamine, which absorbs the carbon dioxide, and the remaining gas is passed through a dryer which removes the water vapour, leaving dry nitrogen. In normal operation a dewpoint of — 30 deg. F. is obtained consistently. Lower dewpoints can be obtained if required.

* * *

The SC.1 VTOL research aircraft, constructed by Short Brothers and Harland Limited, Belfast, recently made its first flight from the Ministry of Supply experimental establishment at Boscombe Down. The aircraft used normal take-off technique and was tested in forward flight.

This flight marked the start of a phase of development expected to continue for some time before the aircraft proceeds logically to unrestricted vertical take-off and transition from hovering to forward flight.

SHEET METAL WORKING ON A TURRET PRESS

EXPERIENCES OF A WIEDEMANN USER

The General Electric Company, Limited, have had two Wiedemann turret punch presses in use in their Switchgear Works, Witton, Birmingham, 6, for some years, and a third machine, British-built under licence from the Wiedemann Machine Company, Philadelphia, and supplied by Dowding and Doll, Limited, 346 Kensington High-street, London, W.14, is now being installed. The machines have eliminated the slow and costly sequence of marking out, drilling, trepanning and punching which used to be necessary for preparing switchgear panels, and have proved themselves equal to several other tasks as well.

Only the basic features of the Wiedemann press need be mentioned. It consists of a compound table, with three sheet-holding clamps, which can be moved in two directions in the horizontal plane, in-out, and crosswise relative to a turret carrying 24 or 32 pairs of tools. The turret is power-rotated under the control of the machine operator, and any chosen pair of tools can be brought into the operating position to work on a sheet of metal which is moved by means of the compound table to bring the required parts in turn under the tools. Each of the three clamps can be retracted, leaving the other two to hold the sheet, while punching is carried out close to the clamping position. All three clamps can be seen in Fig. 1, and it will be obvious that the left-hand one will have had to be moved in order to punch the large hole near to it. Built-in graduated scales on the machine bed, together with graduated collars on the table-operating handwheels, enable the setting of the sheet to be carried out quite accurately. In G.E.C. practice the punching is done under normal production conditions to within ± 1/64 in.; it is possible with special care to work to closer limits, but such accuracy is rarely needed. The saving of time made possible by the press can be appreciated from the fact that panels of the type represented by Fig. 2, which are in 12 s.w.g. (0·104 in.) mild steel, are punched and pierced in one setting, the time required for making some 500 press strokes being about 75 minutes.

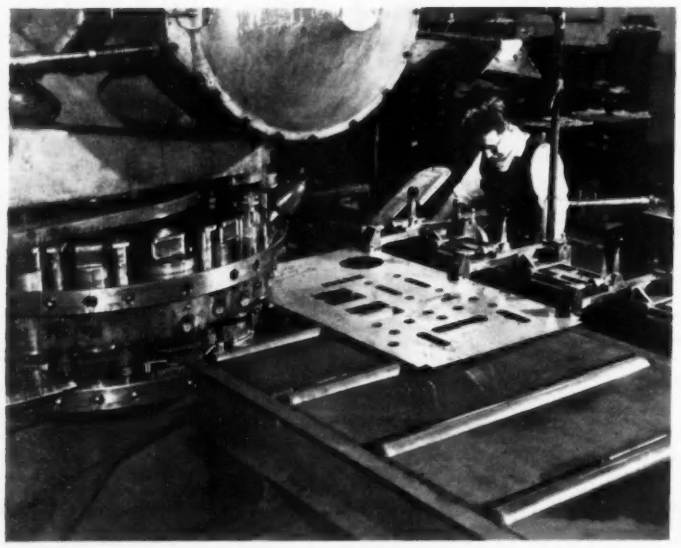


Fig. 1 Turret tooling and method of clamping the workpiece are all visible in this view of a typical panel being produced.

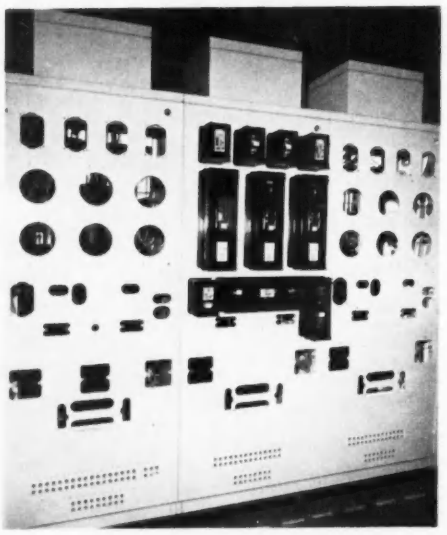


Fig. 2 All the holes in these switchgear panels are produced in one setting on the Wiedemann press.

The information needed for setting the table and turret can be supplied to the operator of the machine in more than one way, but the standard G.E.C. practice at present is to provide a chart giving the individual table and turret settings for each press stroke. Preparation of the charts is the duty of the press charting office, which works from drawings supplied by the drawing office in the normal way. Information on the drawings is usually confined to stating overall dimensions, centre distances to each hole or group of holes, and details of edge-preparation when required, which is usually the case, as most panels have to be corner-notched or otherwise prepared for folding and welding. Holes and groups of holes are identified by standard code numbers, which saves drawing office time. Any special features not covered by the standard coding are drawn out in full.

The operator's working chart is quite simple. Part of a typical chart is shown in Fig. 3. In the top left-hand corner is the basic information on material size and next to it is a column in which the operations are summarised; this column is used as a basis for rate-fixing. It will be seen from this section of the chart that the turret, in this particular instance, moves seven times and the table 168 times, while the press makes 158 strokes. Provision is made in the column for recording the movement of clamps to permit punching which would otherwise involve retracting two clamps together (not required in the example shown), centre-punch strokes from a compressed-air punch working through the centre of one of the larger punches (again, not required in the example), and scrap removals by hand. This occurs when a large aperture or notch is produced by punching round the periphery, leaving a centre portion of scrap to be removed by hand. Details of the punches used are given in the next section of the chart, and immediately following this comes the detailed operating information, each line (except the first one), giving the table setting against the turret station. The first line shows how the clamps are to be set. An operator using the chart shown in Fig. 3 would first set the sheet to the stops, fix the clamps as instructed, and then traverse the turret to station 15. The table would then be set to the in-out and crosswise dimensions shown, and the first punching stroke would be made. The next

Fig. 3 The draughtsman's design is reduced to chart form for the press operator, who is thus given the correct setting for every press stroke.

stroke would be made with the turret setting and in-out dimensions unaltered, but with the crosswise setting at a new figure, and so on until the end of the chart was reached.

Some explanation of the dimensions shown in the crosswise column is necessary. It has been found of practical advantage to state the setting dimensions to the nearest $\frac{1}{16}$ in. and then, if further fractions are involved, to give the number of 64ths needed for the correct dimension. The scales for table setting are marked by $\frac{1}{8}$ in. divisions, the graduations on the handwheel collars are each equal to $\frac{1}{16}$ in., and the fixed zero scale has a sub-scale with $\frac{1}{64}$ in. graduations. All the operator has to do, therefore, is to set his machine table, in the example given, to $30\frac{15}{16}$ in., and then move his handwheel through two divisions on the sub-scale. There is no need for him to remember that the actual dimension required, $30\frac{31}{32}$ in., is really only $30\frac{15}{16}$ in. plus two 64ths; he sets his machine according to the "+2" figure, and his work is simplified, with less possibility of error. The fact that the in-out

column in the chart illustrated does not contain any "plus" dimensions is due solely to the way in which the developed size of the sheet has worked out; if 64ths were needed, they would be shown in the same way.

HOW THE DESIGNER HELPS

The versatility of the press is obvious, but even so, it must have some limitations. Only if it is used without the need for frequent tool changing, and without the necessity for subsequent operations on the workpieces is the press operating to its full potential, and close co-operation is maintained between the G.E.C. drawing and press charting offices to ensure that special work shall be eliminated as far as possible. The ideal is that the Wiedemann press shall do all the machine work on the panel, leaving only the folding and welding to follow as separate operations. Designers are therefore asked to use standard-sized holes. There is a range of round holes from 0·120 in. to 6½ in. diameter, and of square and rectangular holes from 1 in. by 1 in. and ½ in. by 1½ in. respectively, with no upper size limit. It is also expected that as far as possible slots of all sizes shall be at 45 or 90 deg. to the sheet edges, and that narrow slots shall not be less than ½ in. wide and 1½ in. long. This latter requirement can be modified if "ripple" in the slot edges is unimportant, as smaller slots can then be punched by using a circular punch. Any components meeting the standard requirements specified can be produced without changing the tools in the turret.

In practice it has been found that the insistence on standards has not caused any difficulties in the design department; in fact the reverse has been the case, and co-operation between designers and charters has resulted in some appreciable savings. Even when the presses are used for pre-production runs of components which will later be tooled-up for orthodox power press production, the occasions have been rare when the standard tools would not do the job. When a machine will produce components in one-fifth of the time required by other methods, there is a very strong argument for adhering to standard tooling, and this has been, perhaps, the most important fact to emerge from the long experience which the G.E.C. have had. It has also been shown that standardisation within the very broad limits imposed by the press is no hardship.

The latest development in the use of the Wiedemann press at the G.E.C. works is in the matter of charting. This is now in the process of being changed to decimals to enable a Burroughs Sensimatic accounting machine to be used. The new arrangement will not affect the operation of the press, except in so far as the dimensions will appear in decimals instead of fractions, but it will simplify and speed up the charting considerably by eliminating mental calculation. It is believed by the G.E.C. that this application of the Burroughs machine is the first in this country, though such an installation has been in use in the United States for some time.

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MONITORING THE TRANSATLANTIC CABLE

To ensure the efficiency of the transatlantic telephone cable, comprehensive monitoring equipment is necessary. One of the devices used to check on the performance of the submerged repeater units is the display unit manufactured by Kolster-Brandes, Limited, Sidcup, Kent. The monitoring equipment provides a frequency modulated signal which sweeps through the repeater frequency band in 4 seconds. The response of each repeater to this signal appears on the cathode ray tube of the display unit. Position on the trace horizontally identifies each repeater, while the vertical deflection of the trace indicates performance. Because of the low repetition rate the cathode ray tube is provided with an afterglow of 30 seconds. Facilities are available for the operator to compare the performance of each repeater, in magnified form, with a reference signal.

Institution of Naval Architects Spring Meeting

ALTERNATIVE METHODS OF SHIP PROPULSION

At the Spring Meeting of the Institution of Naval Architects, held in London from March 26 to 28, the presidential address, by Viscount Runciman of Doxford, touched on a wide range of subjects, particularly the propulsion of ships. A short report of his address is given below, followed by a report of the first of the technical papers presented at the meeting.

"If one surveys the general state of naval architecture at this time," Lord Runciman said, "it seems to me that the most exciting things in the immediate offing are in the field of propulsion—perhaps the field of the marine engineer. It will be for us to see what he has to offer, and what we can contribute simultaneously with him. It is positively bewildering, if you are a shipowner considering ordering a ship for delivery in that rather distant future in which you may hope to get it from the shipbuilder.

"If you think of the form of propulsion that you will employ, are you to look ahead to gas-turbines? Are you to follow up the American full-scale experiments in controllable-pitch propellers? Or are you to go into the noisier field of the free-piston engine? What about supercharged Diesels—what is the limit of horse-power that you can really expect to transmit to a crankshaft by a series of explosions? Then there is the supercharged boiler, which seems to me a fearsome thing but appears to be capable, under proper discipline, of providing more economical power. What about steam turbines? Let us pay tribute to the immense progress that the Americans have made in this direction, though I think that there is still much that we may learn. What about Diesel-electric and even turbo-electric drive? And, finally, what about nuclear energy? Are we to go on thinking of nuclear power solely as a source of heat, or are we on the threshold of discoveries which will make nuclear energy a direct source of power in itself? I do not know, and I do not suppose that many of you know, either; but it is quite clear that, in the years to come, the practice and the art of naval architecture will be greatly affected by the answers to many of these questions.

"It is good to know that the usual programme of research is going on; and I think that the section of our annual report which gives a summary of the sort of research that is being done is by no means the least valuable part of it. Problems are always changing. If you look at the naval construction for the past year, you will find that something like 50 ships have been completed. That seems a lot, until you realise that, added together, they barely amount to the tonnage of one battleship. When you consider the problems which face the Navy, in cramming into those very small hulls, under reasonable living conditions, the crews who are necessary to fight those ships, you will appreciate the importance of research into habitability.

"There is also the research on higher speed, planing and the like. Metallurgical problems are claiming increasing attention at Dunfermline; and there is the extending use of non-metallic substances. Then there is the question of making oil tankers into submarines. So we come full circle and the naval architect's activities and researches may end (as, very likely, they began) with Jonah in the belly of the whale."

DESIGN OF OCEAN IRON-ORE CARRIERS

The first paper on the Spring Meeting programme was by Mr. James Lenaghan and was entitled "Ocean Iron Ore Carriers—Design Considerations."

At the present time, said Mr. Lenaghan, there were about 57 ore carriers under construction or on order for United Kingdom account alone; and as the requirements of the steel industry for imported ores grew, so would the demand for bulk ore carriers, specially designed for the trade. They could be divided into two main classes, namely, those trading in the eastern and western hemispheres, respectively. Dimensional limitations existed at many ore bases, but were less restrictive than those at the discharging ports. Draught was a fairly general limiting factor at both ends of the ore routes; a fact which the author emphasised by including in the paper tables of berthing restrictions in United Kingdom and overseas ports. He also gave the distances between the principal ore ports; the draughts of ships that could be accommodated; and the densities of the imported ores, ranging from 13·2 to 22·0 cub. ft. per ton. In some cases, he mentioned, the ore might be as light as 30 cub. ft. to the ton.

The paper dealt in turn with the design of the ore compartments (for which new Rules were introduced by Lloyd's Register in 1955) and of hatch openings and covers; ballasting arrangements for single-purpose ore carriers and for those designed to carry either ore or oil; the position of the navigating bridge in long ore carriers; and the economics of fitting ore carriers with self-unloading equipment. On this last subject Mr. Lenaghan said that while at present self-unloaders were extensively used on the Great Lakes of North America, they were exceptional among ocean-going ore carriers. It was possible that the opening of the St. Lawrence Seaway might lead to the development of greater numbers of self-unloaders, suitable for either ocean or Lake services. It had been estimated that the presence of the unloading gear would reduce a ship's deadweight capacity by about 7 per cent. and add 15 per cent. to the initial cost.

DISCUSSION

Mr. J. Hodgson said that, as ore ships had to carry continuously the most unkindly type of cargo, often loaded and discharged by most barbarous methods, they had to be stronger and more robust than the normal type of dry cargo ship, and generally were equivalent in strength to tankers. He agreed with Mr. Lenaghan on the bad effect of restricted draught from both the construction and the stability points of view. Greater depth kept down the thickness of the deck and bottom plating, which was important in welded ships because of the possible adverse effect of increased thickness on the notch ductility of the steel.

The paragraph in Lloyd's Rules to which the paper referred required the longitudinal bulkheads to be a minimum distance of 0·2B from the ship's sides only when a draught in excess of the ordinary cargo ship draught was desired. Watertight sub-division was one of the supplementary conditions of freeboard assignment for deeper loading, and therefore was prescribed in Lloyd's Rules. That condition also governed the spacing of the bulkheads in the wing tanks. Many modern ore carriers operated on the ordinary cargo draught and were not subject to the sub-division restriction; there was then more latitude for positioning the longitudinal bulkheads. Many such ships had greater hold capacities for lighter ores and other bulk cargoes, and it was then usual to crank the longitudinal bulkheads to facilitate trimming and discharge. This avoided any abnormal increase in width of hatchways, and so minimised the thickness of plating alongside the hatchways. Very long

centre holds could be obtained without penalty if flooding of the hold would not endanger the ship.

Mr. Lenaghan's remarks on the position of the navigating bridge were of topical interest in all ships with machinery aft. Many officers, at first sceptical about manoeuvring such big ships from aft, had found that there were no difficulties; though the midship position had the advantage of being away from the noise of the engine, so that the men on the bridge could hear fog signals better.

An important anomaly existed in the register tonnage of that type of ship, when measured under the regulations of different countries, because of the different methods of treating *bona fide* water-ballast spaces. When the tonnage was measured in countries which had adopted the International Tonnage Regulations, the amount of water ballast space which could be exempted or deducted was limited; in a ship of about 10,000 tons gross it was 9·5 per cent., and in a ship of 15,000 tons gross or over, about 7·5 per cent.

In some countries not acceding to the Tonnage Convention, all the water ballast tanks were exempted from inclusion in the gross tonnage, without limitation. Thus there was a great difference between the tonnages of similar ships carrying the same deadweight when measured under the two systems. In a ship of about 24,000 tons deadweight, the gross tonnage measured under the limiting regulations might be more than double that of the ship not subject to the limitation.

DRAUGHT AND DEPTH

Professor E. V. Telfer observed that surprisingly little was known about how draught varied with depth. In the conversion of oil tankers into ore carriers the structural design was comparatively easy to appreciate; but because the conversion to ore carrier also introduced a heavy strengthening of the oil tanker, the effect was to pull down the neutral axis and destroy the structural symmetry of the design. To restore that, a further increase in deck plating was required. Something should be done in the general design of tankers to produce greater symmetry, as was current practice in ore carrier design. Making the stiffening in part transverse rather than longitudinal would help to prevent lowering of the neutral axis. Another method would be to incorporate the second deck in the ore carrier in some position which would restore the position of the neutral axis and give better water ballast compartments than using all the hold. That would more rapidly reduce the effective metacentric height in the ballast condition. The water would then be allowed merely to flow overboard by suitable exits on arrival in port.

He disagreed with Mr. Lenaghan's views about the over-powering of ships beyond the needs of the service, particularly in ships which were turbine-driven, where the cost of over-powering was not nearly so heavy as with other types of propulsion. Extra power could be of great importance in keeping to schedule.

Mr. J. S. Terrington thought that the length-to-draught and beam-to-draught ratios must be a compromise if deadweight tonnage was more economically obtained by deepening the draught. As, however, draught was the limitation at many ports in the United Kingdom and overseas, it was desirable to keep the draught as shallow as possible for a given tonnage; in other words, for maximum load it was desirable to increase the L/d and B/d ratios. It seemed desirable to standardise the sizes of ships to conform with the sizes of the ports, rather than to adopt random sizes.

Mr. Lenaghan had advanced technical reasons why the longitudinal bulkheads should be vertical and not "hoppered," but on operational grounds some people preferred hoppered sides. Deck overhang was an important factor and could cause damage to the unloading grabs.

Dr. J. F. Allan said that it was a real problem to design the ends of ore carriers so that the ships would be seaworthy and controllable, and reasonably easily propelled. The more draught the better, from the point of view of strength and capacity, and of propulsion, but if increased draught were obtained, the fullness of the ship would not be in any way reduced, and probably the propulsion would not be much improved; the ships were of so full a form that it was not possible to make a really satisfactory job of either end. He was surprised that there was not more trouble with the propulsion of such very full vessels. The indications from model testing were that there would be separation and consequent breakdown of flow; yet quite a number of them had done extremely well in service.

It is interesting to know that the American Lakes bulk ore carriers were considerably fuller than the ocean-going carriers, with coefficients as high as 0·86 and even 0·87. They were driven very hard and there must be separation at the after end; yet they had a very good efficiency. There was no doubt about the saving of time effected by the use of self-unloading equipment, but it represented a large capital investment, and it would seem that, unless the ships were working on short hauls, the investment was barely justified.

Mr. J. M. Murray, M.B.E., said that, while the addition of material would lower the neutral axis, it also increased the inertia, and the position of the neutral axis was not affected. That point had been raised from time to time and it was worth some consideration. Mr. Lenaghan suggested that in the ore carrier proper, there should be one side passage for the crew and for cables, and two in the combined ore and oil vessel. It was always useful to make such passages strength members, and from considerations of symmetry alone he thought it important that there should be two passages in both types of ship.

Mr. J. Burton Davies suggested that Mr. Lenaghan's list of berthing restrictions in United Kingdom ports would be still more useful if some of the European discharging ports were included; for example, there was a very heavy traffic in Swedish ore from Narvik to Antwerp, and, he understood, through Rotterdam. The larger "eastern" carriers were single-purpose ships, but there was one fleet of smaller ships which regularly took ore from the Baltic to England, returning with refined petroleum products. If more coal became available for export, there should be a future for such a trade.

ECONOMIC CRITERIA

Professor A. M. Robb said that Mr. J. S. Terrington, the representative of B.I.S.R.A., had made a remark which should not go without challenge in a gathering of shipbuilders and shipowners. He referred to the damage caused to the grabs by the ship. Surely it should be stated the other way round; the treatment given to the ship by the grab was barbarous.

Mr. W. F. Spanner supported Mr. Lenaghan's plea for simplicity in the design of ore carriers, and suggested that a strong case could be made out for fitting a steam reciprocating engine with exhaust turbine to ore carriers of 12 to 13 knots, in the smaller sizes. He thought also that a good case could be stated on economic grounds for building a rather larger number of smaller carriers to give the same rate of supply between two ports, rather than building a smaller number of larger carriers.

Dr. W. Muckle said that, from a structural point of view, the most economical structure would be one which was completely balanced, i.e., where the neutral axis was at half the depth. He considered that that should be the aim, and suggested that it might be an improvement to make the two flanges of the same thickness and so to get the neutral axis at half depth.

The author, in reply, said that he was interested in a remark by Mr. Hodgson, that the midship bridge position might be better than the aft position from the point of view of vibration from the engine, but thought it would be no worse than with the bridge aft and a midship engine. He had seen designs for ships of 600 ft. length and more with the after bridge position, but, though he had advocated the after bridge position for a long time, he would not like to see a ship of 600 ft. with the bridge aft; such long ships needed a navigating position forward, though perhaps not the full bridge. As to tonnage measurements, presumably Mr. Hodgson was referring to net tonnage; in one case the net tonnage for a 4,000 ton ore carrier registered abroad was some 5,000 tons, whereas in the United Kingdom it would be something like 17,000 tons.

Mr. Lenaghan did not agree that longitudinal bulkheads should be hoppered. From the strength point of view it did not matter, and in the course of long negotiations on the question he had found that no two people agreed; so he had come to the conclusion that the shipbuilders themselves should settle the matter and make the bulkheads straight. Flat bulkheads were easier to construct and were certainly cheaper.

He was surprised by Professor Telfer's remarks on over-powering, because in 1952, in the discussion on Sir Wilfrid Ayre's paper on "Merchant Ship Design" he had almost agreed with Sir Wilfrid's suggestion for a fuller ship. There was no reason why ore carriers should not be fuller. Mr. Lenaghan saw no point in spending money to put in more power than was needed unless a ship was on a world tour, when there was a case for having extra power; but when a ship was doing regular voyages, there was no point in over-powering. In 1951 that matter was considered carefully, taking two types of engines, Diesel and steam, and it was decided that, with one design, ore could be carried for about 2*d*. per ton less. When the design was being developed, a further cylinder was taken off the Diesel engine, and the ship carried the ores at a substantially cheaper rate. The whole thing boiled down to economics; the ship must have a good hull, but the margin of power provided to take care of bad weather could be kept to a minimum.

Dr. Allan did not agree with the views expressed in the paper on the question of fullness; but he had been surprised by the success of some of the full ships. The "Moisie Bay" had a block coefficient of 0·80 and a draught of 30 ft., and the "Free State" had a little more draught. They bore out what had been said about fullness, and they were doing very well.

The 7 per cent. loss of deadweight capacity caused by fitting unloading equipment into ore carriers was the figure worked out for a sister ship of one of the ships building by the Fairfield Company at Govan. He did not think the Great Lakes carriers could do without unloaders, because some of them are in and out of port 40 times in a year, and they could not be discharged with grabs as quickly as with unloaders.

Reports of other papers presented at the I.N.A. meeting will be published in subsequent issues of ENGINEERING.

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INDUCTION HEATER

A 1 kilowatt induction heater has now been put on the market by Radio Heaters Limited, Eastheath-avenue, Wokingham, Berkshire. It is available in three models, designed for specific purposes. The first is intended for vacuum tube out-gassing and has a 7 ft. low-loss flexible lead attached to it. The second is a 5 Mc/s laboratory furnace for hydrogen determination in titanium, or for carbon determination in steel; and the third has a 1 Mc/s unit for soldering and brazing with three output tappings. All units are designed to work from the 250 volt mains at 50 or 60 cycles and have a consumption of 6 amperes. Water at 20 lb. per sq. in. is required for cooling the work coil and the leads. Inlet and outlet connections for this are made at the rear.

A DIESEL LOCOMOTIVE WITH UNUSUAL FEATURES

Ruston and Hornsby, Limited, Lincoln, now include in their range of Diesel locomotives a 333 h.p. unit of medium power, intended to perform the work which would be carried out by a 16 in. or 18 in. steam locomotive. We recently had an opportunity of seeing this Mark LWS Diesel locomotive at work at the Drakelow power station, East Midlands Division, of the Central Electricity Authority. The weight of coal handled daily at this power station is some 2,700 tons. It is not uncommon for the same wagon to arrive with coal twice in one day—testimony to expeditious handling by the power station, British Railways, and the colliery concerned.

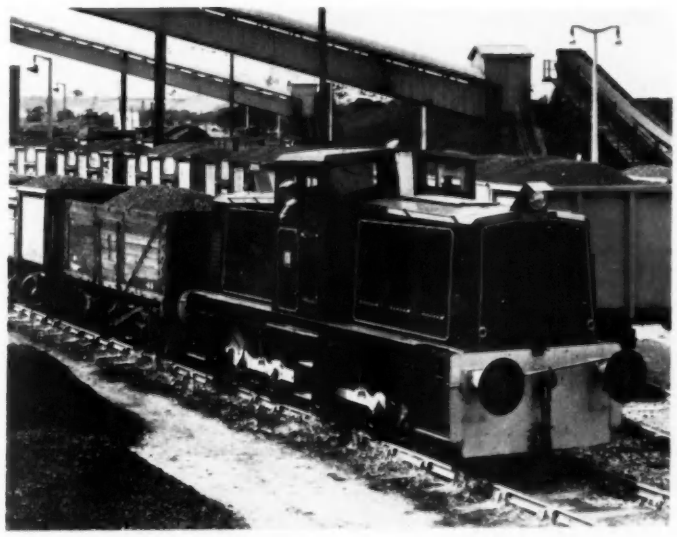
The LWS locomotive contains a number of special features. The jackshaft design and gearbox location avoid the gearbox casing being subjected to the normal driving loads. The final drive shaft is, in fact, a sleeve and the jackshaft is carried on bearing housings mounted on the frame side-plates, which take the loads. The crankpins by means of return cranks and telescopic connections.

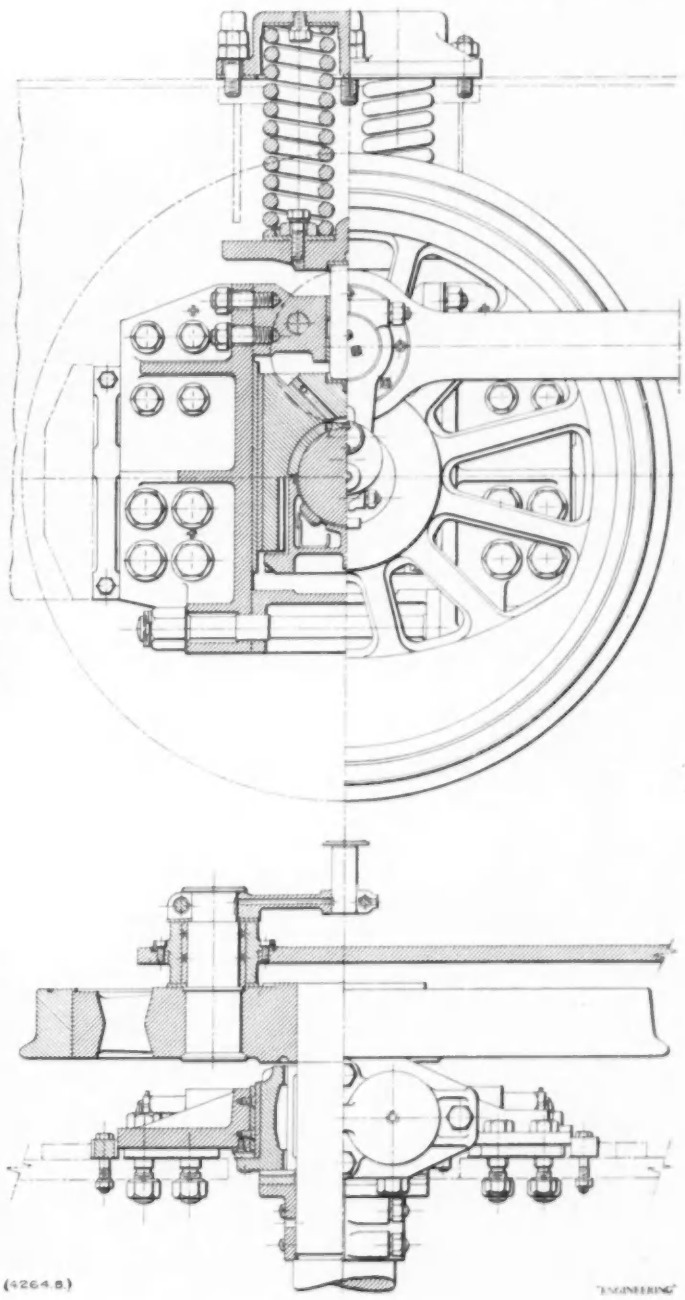
The four-speed gearbox is of the constant-mesh type, each speed train being brought in by an oil-operated cone clutch patented by Ruston and Hornsby. Reversing is by bevels and dogs, facilitated by a disconnecting clutch of the type mentioned. The Drakelow locomotives incorporate special gear ratios which give rail speeds below normal values, as shown in the table.

The standard Diesel unit for the new LWS locomotive is the Paxman 8RPHL; with cylinders 7 in. bore by 7½ in. stroke arranged in V banks, it develops 333 b.h.p. at 1,250 r.p.m. Following the makers' usual practice, the locomotive frame is entirely welded.

Measured over buffers, the length is 27 ft. 1 in., the extreme width is 8 ft. 6 in. and the overall height 11 ft. 9½ in. The weight in working order is 44 tons. This type of locomotive is available in gauges from 1 m. (3 ft. 3⅜ in.) to 5 ft. 6 in.

Gear	Drakelow Locomotive		Standard Locomotive	
	Speed, m.p.h.	Tractive Effort, lb.	Speed, m.p.h.	Tractive Effort, lb.
1	2·5	24,200	2·7	24,640
2	4·5	20,800	4·96	18,900
3	8	11,700	9·5	9,900
4	14·5	6,400	18·5	5,060





(4264.8) "ENGINEERING"

Fig. 1 (above) Medium-power Diesel locomotive with a number of design features which facilitate maintenance.

Fig. 2 (right) Axlebox, suspension and coupling rod. The design allows the axlebox to be removed easily by jacking up the locomotive, when it can be slid along the axle. The coupling rods are of fabricated construction.

drive is transmitted from the final drive sleeve to the jackshaft by splines. The makers claim that the ability to withdraw the jackshaft sideways, should it be required to remove the gearbox, is unique on this size of locomotive. On the other hand, should it be more convenient to drop the jackshaft, in the normal way, this can be done.

The axleboxes are of the single-flange type, as shown in the drawing, and are steel castings. Split thrust collars are mounted on the axles on the insides of the boxes, no provision being made to take thrust between the inside face of the wheel hub and the outside face of the box. The thrust faces of the collars are lined with anti-friction material, which can easily be renewed when necessary.

A further interesting point is the ease with which axleboxes and liners can be changed. By jacking up the locomotive the complete axlebox may be slid inwards, after removing the split collar. The bronze liner has its bore concentric with its outside diameter, and should renewal be necessary taking the weight off the box concerned allows the liner, after the keep has been removed, to be knocked round the axle. A new liner is inserted in the reverse manner.

The connecting and coupling rods are profile flame cut from plate, and fitted with cast-steel bossses at the ends to provide bearing areas, as shown in the plan. In place of wrist pins the rods are themselves pivoted around the crankpins. The whole of the running gear is mechanically lubricated from a Wakefield lubricator; an unusual feature is the mechanical lubrication of

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FLAME HARDENING

To harden the starter rings for automobiles, Francis B. Wilmot (Dalmans), Limited, Cheapside, Birmingham 12, have installed a British Oxygen flame hardening process. Each starter ring is rotated at a speed designed to give a uniform distribution of the heat throughout the peripheral regions of the ring. While it rotates, six torches play on it. The heating is controlled by an automatic timing mechanism, and the ring is subsequently quenched in a water-based soluble oil. The gears are made from medium carbon steel and the hardness obtained in the teeth is in the range of Rockwell C 47 to 52.

A DESIGN CASE HISTORY

By P. J. Fletcher, D.L.C.*

The teething troubles inevitably associated with a novel design of machine and how they were overcome are described in this article. It goes on to show how the modified machine, a prototype rotary rock-drill, provides valuable design information for future models.

The use of rotary drilling techniques in mining practice has been restricted in the main to two fields. The first embraces the use of hand-held machines of low power for drilling shot-holes in coal; the second includes machines of higher power for drilling rounds of shot-holes during tunnelling operations, usually in stone. Recently, machines of the second category have been adapted for drilling holes sometimes as much as 150 ft. in length in both rock and coal for such purposes as methane drainage and, when drilling is carried out parallel to the coal face, for experiments in blowing down coal along the entire length of the working face. For the latter purpose, the machine must be housed and operated in a stable-hole at the end of the face, and since the cutting of such a stable-hole is an expensive matter the machine must occupy as little space as possible.

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Existing types of rig-mounted rotary drills employ either lead-screw or rack-and-pinion mechanisms to provide feed for the drill rod, and are thus extravagant in size, since they require sufficient space to accommodate the combined lengths of the machine, its feed mechanism and the drill rod. The following article describes the mechanism of an experimental machine of compact dimensions, novel in the fact that it transmits both rotary and axial drive to a smooth tubular drill rod without the use of any external feed mechanism. The rod passes through the machine, and extra lengths can be added as required from the rear. Here it should be mentioned that although the machine was evolved specifically to drive a tubular drill developed by the National Coal Board, the drive is applicable in principle to any smooth cylindrical rod. It is shown, mounted on an experimental rig, in Fig. 1.

MECHANISM FOR SIMULTANEOUS ROTATION AND FEED

It is comparatively easy to arrange for a smooth rod to be gripped by a collet or similar device sufficiently tight to provide enough torque to drive a rotary drill, but to superimpose on the rotation a variable axial feed in either direction is more difficult. In principle the mechanism adopted consisted of a friction ratchet to which was imparted an angular oscillation, so that it alternately gripped and released the drill rod, causing intermittent rotation of the latter. Superimposed on the angular oscillation of the ratchet unit was an axial reciprocation provided by cams, so synchronised that the resultant intermittent motion of the drill rod was along a helical path. The feed cams, mounted on the rear faces of the ratchet unit, were so designed that their positions could be set to give various feed rates in either direction.

A drilling machine embodying only one unit such as that described would obviously be inefficient because of the intermittent nature of

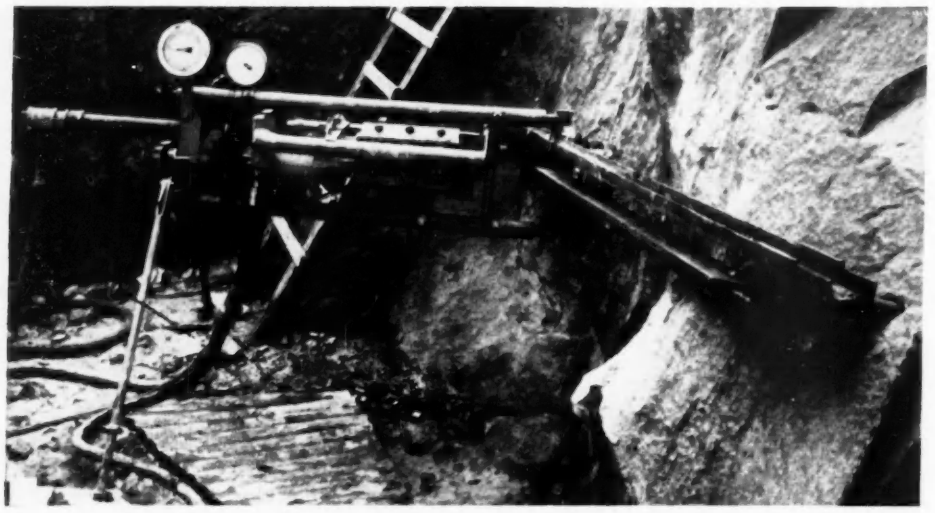


Fig. 1 The modified rotary rock drill mounted in an experimental rig for reliability trials. The motor unit imparts a substantially uniform rotary and axial drive to the drill rod. The improvements to the prototype had been made following extensive laboratory tests.

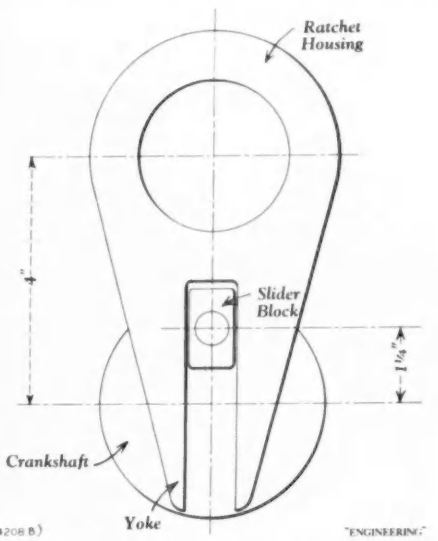


Fig. 2 Quick-return motion used to impart an angular oscillation to the ratchet unit.

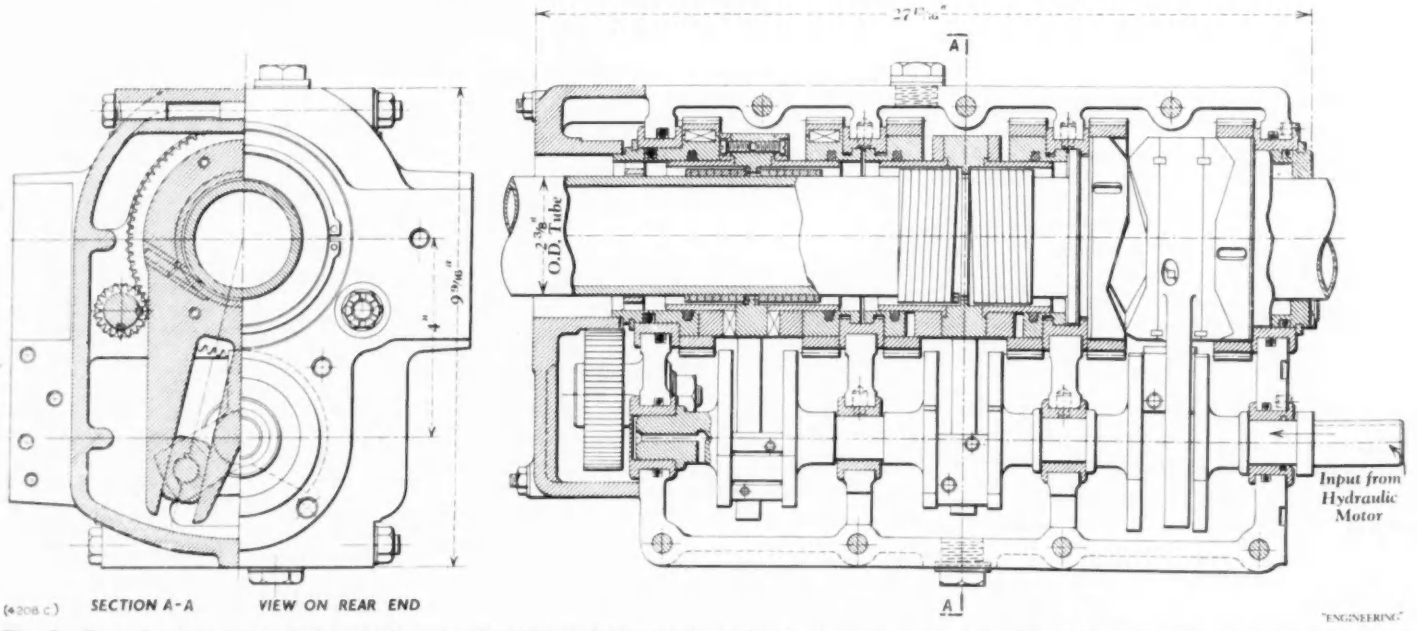


Fig. 3 General arrangement of the machine. In the right-hand drawing the casing is shown removed. The three identical ratchet units are driven from a common crankshaft, and together give a substantially uniform motion to the drill rod.

the drive, and a more uniform motion has been sought by combining three identical units arranged so that their working cycles were 120 deg. out-of-phase with each other.

MECHANICAL DESIGN

An estimate of the power required to drive the machine suggested the provision of a 10 h.p. motor; this was sufficient to maintain a torque of 200 lb. ft. up to a drill speed of 250 r.p.m. while still leaving 1 h.p. available for producing thrust.

Motive power has been provided by a Keelavite G115 gear-type hydraulic motor giving 10 h.p. at 1,150 r.p.m., and driven through flexible hoses by an electrically-powered pump. The inherent advantages of high power/weight ratio and constant-torque characteristics possessed by hydrostatic hydraulic systems were the principal factors influencing the choice of this type of

Fig. 5 Ratchet unit of the prototype machine incorporating two close-wound springs. The action of the friction grip resembles the familiar no-return ratchet on the winding spindle of a camera.

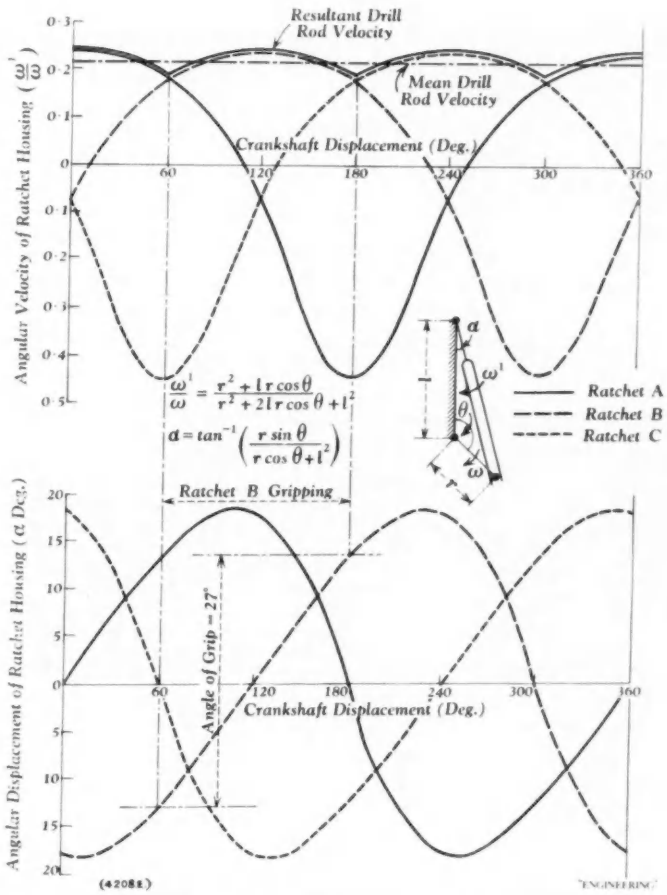


Fig. 4 Angular velocity and displacement diagrams for the three-throw crankshaft, showing the uniformity of motion obtained and the period for which each of the ratchets is effective.

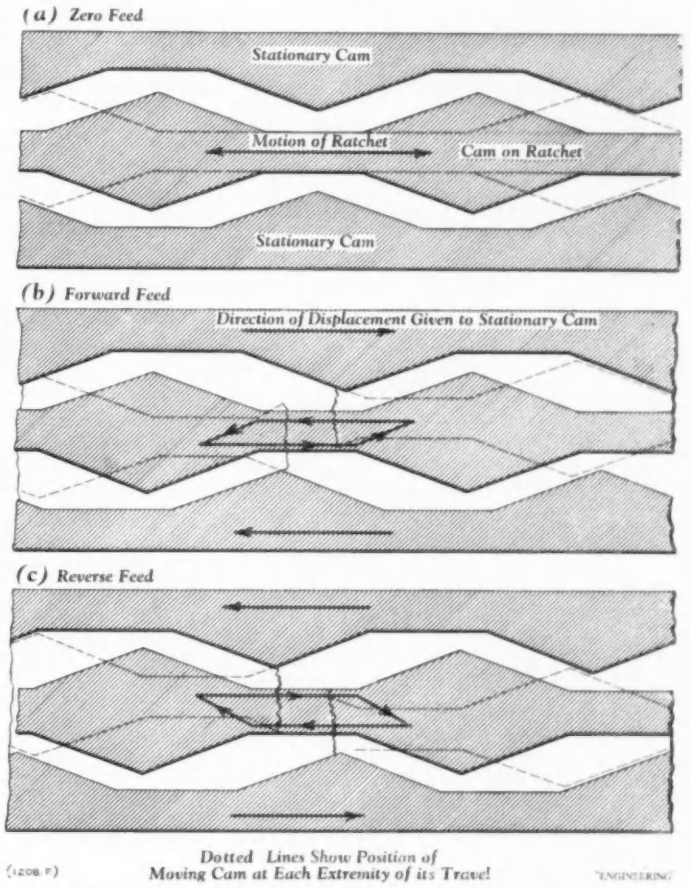


Fig. 6 Development diagrams of the feed cam profiles which are to be seen in Fig. 5. The relative displacement of the moving to fixed cams is as shown.

motive power for the machine from the beginning.

Angular oscillation was given to the ratchet units by an inversion of the Whitworth quick-return motion, which is shown diagrammatically in Fig. 2. The ratchet housing was provided with a forked yoke which engaged with a slider block running on the pin of a crankshaft mounted parallel to the axis of the drill rod. From the general arrangement drawing, Fig. 3, it will be seen that the crankshaft had three throws, and by spacing these equally the angular oscillations of the ratchets were displaced 120 deg. out-of-phase with each other. In considering the translation of angular oscillation of the ratchets into rotation of the drill rod, it must be borne in mind that if more than one ratchet is rotating in the forward direction a powered drive will only be transmitted through that having the greatest angular velocity, since the motion of the others relative to the drill rod will be in the reverse direction, and they will therefore be slipping. Fig. 4 shows the variation of angular velocity and displacement with crankshaft position for each of the three ratchets, and from these curves it may be seen that each grips for approximately 27 deg. rotation of the drill rod, neglecting any backlash in the ratchet. In Fig. 4, ratchet A has the greatest angular velocity of the three at $\theta = 0$, and tracing the motion of this ratchet shows that it will transmit drive until it reaches a point where its velocity has been equalled by that of ratchet B. Immediately after this point, i.e. from $\theta = 60$ deg., ratchet B takes over the drive, and continues until in turn its velocity is exceeded by that of ratchet C. Thus the motion imparted to the drill rod is continuous, with about $\pm$ 15 per cent. variation about the mean value, and can be likened to an unsmoothed rectified three-phase voltage.

After several unsuccessful experiments with wedging roller and ball ratchets, the most suitable type of ratchet was found to be one incorporating a close-coiled spring surrounding the drill rod. The spring was wound from square-section wire to such a diameter that it fitted tightly round the rod, and one end was held firmly in the ratchet housing. Rotating the housing in the direction which tended to tighten the spring produced a powerful frictional grip, whereas opposite rotation uncoiled the spring and allowed it to slip. A sectioned view of the ratchet unit is shown in Fig. 3, and the complete assembly can be seen in the photograph of Fig. 5. In each unit, two springs were installed back-to-back, with their driving ends secured diametrically opposite in order to balance-out side loads during drilling. The driving ends of the springs were gripped between pairs of collets driven together in tapered bores in the housing. The springs were made from $\frac{5}{32}$ in. square-section stainless steel, and were wound 0·020 in. smaller in the bore than the outside of the drill rod.

From the cylindrical housing, a forked yoke projected at right-angles to the longitudinal axis, and this formed the slider-bar of the quick-

return motion. The inner faces of the yoke were ground to provide bearing surfaces for the slider-blocks.

The mechanism for providing the forward and reverse feed is to be seen in Figs. 3 and 5, and a developed drawing of the cam system is shown in Fig. 6. The photographs show that face cams were mounted on each end of each ratchet unit, and that these engaged with corresponding cams fixed to the machine casing in such a way that they could be set at various angular positions to alter the direction and the rate of feed. The developed profiles show how the system operated. Sketch (*a*) of Fig. 6 shows the position of the three relevant cam faces controlling the feed of one ratchet, in this case set for zero feed. Oscillation of the ratchet, that is the centre cam strip in the sketch, does not cause engagement of the lifting surfaces of the cams, so that no axial movement of the ratchet takes place. In sketch (*b*) the two outer cam strips, i.e., those fixed to the casing of the machine have been given equal and opposite displacements from the zero-feed position. This corresponds to the forward-feed position, and from the line shown arrowed in the sketch may be traced the path of a point on the ratchet unit. Thus, as the ratchet was oscillated, it was given an axial movement the magnitude of which depended on the displacements given to the fixed cams on either side of it. The third sketch (*c*) demonstrates that by reversing the direction of the displacements given to the fixed cams the axial motion could be reversed to allow the drill to be withdrawn.

The three-throw crankshaft had four main bearings running in "Reservoil" oil-retaining sintered phosphor-bronze bushes, and was turned from a solid billet of En 25 nickel-chrome-molybdenum steel. Each crankpin carried a phosphor-bronze slider-block which served to transmit the motion of the crankshaft to the ratchets through the forked yokes.

The machine was intended to operate in a horizontal position, and all parts were lubricated by splash from the webs of the crankshaft, which ran partially submerged in a sump formed by the lower part of the machine casing. This was filled with an extreme-pressure lubricant of viscosity SAE 80. Synthetic-rubber "O" rings were installed at all positions where oil could leak from the bearings, and were given an initial coating of molybdenum-disulphide lubricant to prevent tearing of the rings before oil reached them.

Photographs of the machine partially stripped and assembled are shown in Figs. 7 and 8.

LABORATORY TRIALS

Very early in the history of the machine it was found necessary to replace the stainless steel springs, which had been chosen to resist corrosion, by a set made of plain carbon steel. This was necessary because severe tearing of the surface of the drill rod was encountered, even on no-load; this was attributed to the notoriously poor bearing properties of stainless steels. Several 3 in. diameter holes were eventually drilled in a block of Darley Dale sandstone, which although abrasive, is not particularly difficult to drill. The performance of the machine was disappointing, as it was not possible to drill at anything like the penetration rate of 4 ft. per minute which had been expected.

In addition, there were audible and visible signs of severe shock loading which was eventually traced to the feed cams. It can be seen from the sketches of Fig. 6 that the feed-cam lift was effected at constant rate at any point on its surface, and that the variation of feed rate was obtained by using different amounts of the surface. Thus at any condition other than full feed in either direction and, of course, zero feed, the gripping stroke of the ratchet started with zero axial feed, which continued until the two cam faces met abruptly. This explained the shock loading. Several ratchet springs were also found to be broken, and subsequent tests showed that heat-treatment had been incorrectly carried out. A certain amount of suspicion also fell on the method of securing the springs in their housings. As the collets were forced into their tapered bores it was inevitable that the springs also moved over with them, and it was impossible to ensure that they were all concentric with each other when installed. When a drill rod was inserted into the machine, it centralised all the springs, but, due to the rigid fixing, could only do so by introducing bending stresses into the driving ends. This prestressing probably contributed to the premature failure experienced.

As mentioned previously, each spring theoretically gripped the rod for 27 deg., but on test the actual angle was less than half this amount due to backlash in the ratchets. On the return, or slipping stroke, the springs were so flexible that they uncoiled too much before slipping, thus permitting the backlash.

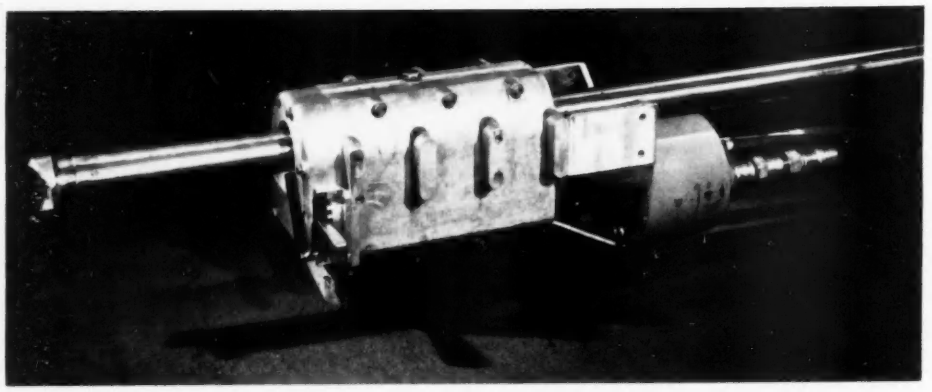


Fig. 7 The assembled prototype as originally designed and before the modification of the feed mechanism.

Fig. 8 The partially stripped prototype machine of Fig. 7, with the hydraulic motor removed, showing one of the two lay shafts by which the feed was varied.

DRILL BIT AND RODS

The rods were constructed from two concentric tubes of 14 s.w.g. mild steel tubing, the outer being $2\frac{3}{8}$ in. o.d., and the inner being $1\frac{1}{2}$ in. o.d. Debris was evacuated by a stream of flushing water fed between the two tubes and emerging from the tubular drill bit just in front of each cutting edge. The mixture of drillings and water then flowed back down the bore of the inner tube, and was thus prevented from entering the machine and causing damage. The bits were designed to drill holes of 3 in. in diameter.

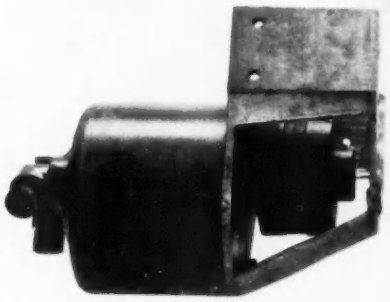
DESIGN MODIFICATIONS

At this stage, a review of the existing knowledge concerning the behaviour of the machine was made and, as a result, it was decided to make considerable modifications using, however, as many of the original parts as possible.

It was realised that beryllium-copper offered many attractions as a material from which to make ratchet springs, as it was highly resistant to corrosion, possessed adequate strength, and would bear against the mild-steel drill rods satisfactorily. Unfortunately, this material was in extremely short supply, and phosphor-bronze had to be used as a substitute. In view of the excessive backlash experienced with the steel springs, the section of the wire was increased to $\frac{1}{4}$ in. square to provide extra stiffness. It had previously been ascertained that a miniumum of eight turns was necessary to ensure a reliable grip on the drill rod, so that with the increased wire section the overall length of each spring was greater, and there was room for only one spring in each housing.

The method of securing the driving end of the spring was also re-designed, and is shown in Fig. 9. Before the spring was wound, one end of the wire was upset into a circular enlargement of the same thickness as the wire. This was used as a fixing when the spring was being wound on a special jig in a lathe, and ensured that the

Fig. 9 Re-designed spring end fixing with the anchorage formed directly on spring root. The helical seating on the cover plate supports the spring, preventing distortion due to axial thrusts.



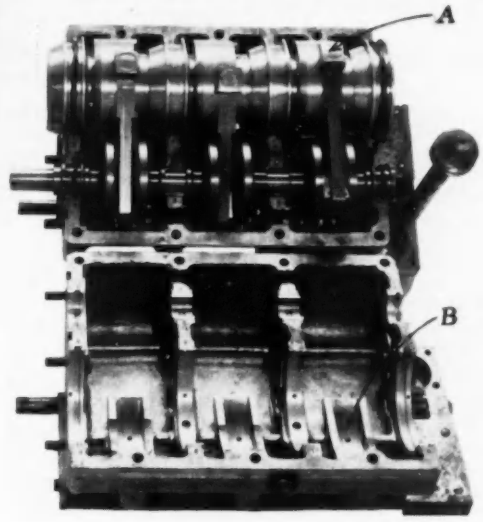


Fig. 10 Assembly of the re-designed machine, the upper illustration showing the casing opened to reveal the modified feed mechanisms. The slider block, A, engages in inclinable guides, B, to give a helical motion of infinitely variable pitch to each ratchet unit. The lower view shows the linkage used to synchronise the movement of the guides.

distance between the centre of the enlargement and the axis of the spring was correct; that is to say, all springs would be in line when the machine was assembled. The enlargement fitted into a circular recess in the ratchet housing, and sufficient side clearance was left between the straight section of the spring wire and the housing to allow a few degrees of movement without straining the spring. The lower right-hand component in Fig. 9 is the cover plate for the spring housing and embodies a helical face to give full support to the initial coil of the driving end of the spring while it is transmitting the drilling thrust. All forming of the spring was carried out cold with the wire in the hard-drawn condition so that the strength and elasticity of the finished spring were not impaired.

The original cam system was discarded and a fresh design prepared to give an infinitely variable feed in either direction without shock-loading. In this new design, shown in the photographs of Fig. 10, each ratchet unit had projecting from it on either side a short shaft at right-angles to the slot in the yoke, carrying a phosphor-bronze slider-block (A in Fig. 10). On each side of the interior of the casing of the machine lay channel-section guides (B in Fig. 10) in which ran the slider-blocks of the ratchet units. These guides were so mounted that opposite pairs could be inclined equally and oppositely to form an approximation to a section of a double-start thread of infinitely variable pitch. Thus movement of the slider-blocks as the ratchet units were oscillated imparted an axial component to the latter, resulting in a helical motion having a pitch dependent on the inclination of the guides. Each of the three ratchet units was provided with an identical system, and the systems were linked together externally.

All other parts of the machine were taken from the original design, and the complete re-designed machine is shown in Fig. 1, mounted on an experimental rig, ready for its reliability trials.

FIELD TRIALS

The machine was intensively tested in a quarry of Portland limestone, providing much useful information. In general, the condition of the components after several hours of running was excellent, and no undue wear was experienced, even on the ratchet springs. Two springs failed during the tests as a result of a type of fatigue associated with relatively few cycles at high stress, but the principal cause of this was unforeseen peak loads occurring during the drilling process, thereby resulting in dangerously high stresses in the wire.

The actual drill speeds obtained on load were considerably below the design values due to backlash on the ratchets. Backlash in each cycle was only a few degrees, but when multiplied by the number of cycles necessary for one revolution of the drill rod the total lost motion was considerable. For instance, at a crankshaft speed of 600 r.p.m., a drill speed of 135 r.p.m. should have been obtainable. On no load, the drill speed was actually 110 r.p.m., dropping to about 80 r.p.m. when drilling at about 2 ft. per minute. Thus, when drilling, the velocity ratio between crankshaft and drill rod was about 70 per cent. greater than the design value.

The choice of hydraulic power to drive the machine proved entirely satisfactory, giving a usefully constant torque characteristic over a wide range of operating speeds. An additional advantage was that a predetermined maximum motor torque could be set by the pressure-relief value in the circuit, minimising the risk of serious damage to the machine in the event of a sudden and complete stall.

In conclusion, it can be said that the main object of the work described in the preceding article—to provide design data on this unusual type of drive mechanism—has been successfully achieved. It now remains to embody this experience in a design suitable for production.

Acknowledgments.—The author wishes to thank the director-general of scientific research, National Coal Board, for permission to publish this article, and stresses that opinions expressed in it are not necessarily those of the Board.

Acknowledgment is also made to those members of the staff of the Mining Research Establishment, Worton Hall, who have from time to time contributed towards the design, construction and testing of the machine.

★ ★ ★

Harland Engineering Company, Limited, Alloa, have been awarded a contract, by the Central Electricity Authority, for the four boiler feed pump groups for the new West Thurrock Power Station, to be built on the north bank of the Thames. The groups, each comprising booster and boiler feed pumps with motors of 1,650 h.p. and 6,500 h.p. per set, are likely to be among the largest ever commissioned in Europe.

ELECTRON AND OPTICAL MICROSCOPY SERVICE

Laboratory Opened Near London

The primary aim of the Aeon Laboratories, Beech Hill, Ridgemead-road, Englefield Green, Surrey, a newly established research organisation, associated with W. Wykeham and Company, Limited, 17-19 Cockspur-street, Trafalgar-square, London, S.W.1, is to provide a specialist service in electron and optical microscopy for research workers in universities, research associations and industrial laboratories. Another function of the Laboratories, which were officially opened on April 11 by Professor G. W. Austin, O.B.E., Goldsmiths' Professor of Metallurgy in the University of Cambridge, is to train scientists in the operation and maintenance of the electron microscope and in the preparation of specimens. To further these aims the Laboratories are equipped with an electron and a range of optical microscopes, equipment for specimen preparation, workshops and photographic facilities.

The electron microscope is an Elmiskop I, made by Siemens und Halske A.G., Siemensstadt, Berlin, and is capable of resolving 10 Å. One of its technical features is the double condenser lens system which enables the specimen to be illuminated to a high intensity without the risk of damage. With the three-stage electron optical system provided, the image may be magnified on the fluorescent screen from a minimum of 200 diameters to a maximum of 160,000 diameters. A viewing telescope is provided on the instrument which allows the image on the screen to be magnified a further 10 diameters, so giving a total maximum magnification of 1,600,000 diameters. It is of interest to note that, at this magnification, a distance of 10 Å on the specimen corresponds to a distance of 1·6 mm. in the image plane.

A further advantage of the three-stage electron optical system is that simply by changing the lens settings the microscope may be used as a transmission diffraction camera, and diffraction patterns may be obtained from a small selected area of the specimen which had previously been examined with the instrument used as a microscope. The images obtained may be recorded photographically, a twelve-plate camera chamber being provided.

The optical microscopes available in the Laboratories have been manufactued by Ernst Leitz G.m.b.H., Wetzlar, Germany, and are suitable for both visual examination and the photographic recording of the images. Attachments are provided allowing the microscopes to be used for both transmitted and reflected light and for polarised light, field illumination and phase contrast. The photographic recording may be carried out on plates or on 35 mm. film.

The range of studies carried out at the Laboratories includes investigations on biological materials, metals, fibres, plastics, powders and greases, and the specimen-preparation room is equipped with apparatus for the production of thin sections, mechanical and electro-polishing instruments, and apparatus for the preparation of replicas for electron optical examination. The dark rooms are equipped with enlargers suitable for plates and 35 mm. film, a copying camera, and a micro-film reader and projector.

Scientists having experience in electron microscopy but not having available an electron microscope of high resolution, may make use of the Aeon Laboratories; the electron microscope being made available on a daily basis for such work. Alternatively, for those laboratories where no electron microscope is at hand and yet in which an occasional demand for high-resolution microscopy arises, the staff of the new Laboratories are ready to co-operate in the development of preparation techniques and the examination of specimens. The Aeon Laboratories have been equipped during the past six months and, up till now, some 1,500 electron micrographs have been obtained from a wide variety of specimens.

THE 275-KV "SUPER-GRID"

MEETING THE GROWING DEMAND FOR ELECTRICITY

During 1956, 511 circuit miles of 275 kV line were completed by the Central Electricity Authority. Thirty-five 275 kV circuit-breakers and 20 120 MVA, 275/132 kV auto-transformers were also installed. As a result an appreciable portion of the new 275 kV "super-grid" was brought into operation and the plan, which had been prepared in 1950 to improve electricity supply conditions in Britain, began to take definite shape. Although a considerable amount of information on this super-grid has already been published, the position was brought up to date in a lecture which was delivered by Mr. F. J. Lane, deputy chief engineer (Transmission), Central Electricity Authority, to the 19th annual meeting of the American Power Conference in Chicago at the end of March; and of which we give an account herewith. An outline of this 275 kV system, as completed up to the end of 1956, is shown on the map reproduced in Fig. 1, while Fig. 2 illustrates the developments which are likely to take place between now and 1965.

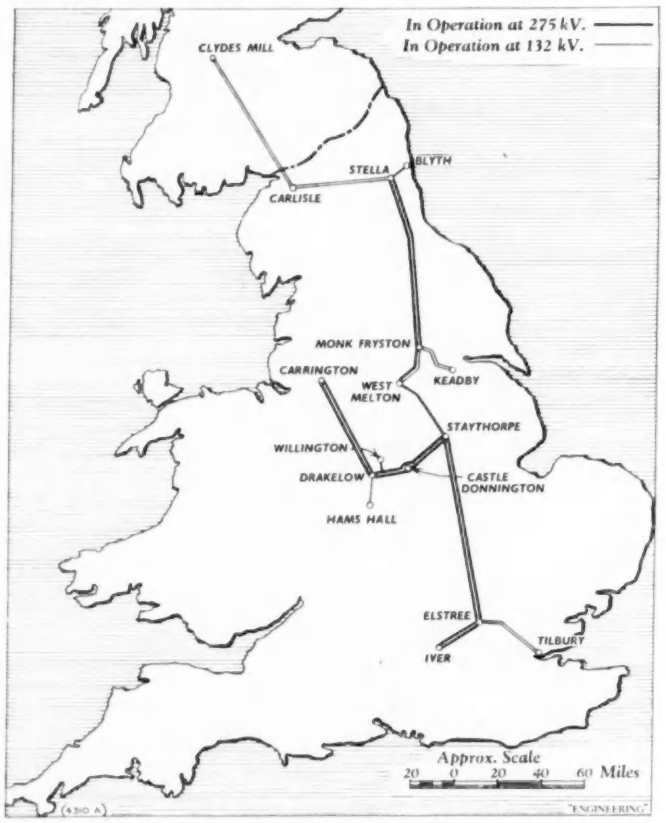


Fig. 1 Map of 275 kV "super-grid" at December, 1956, showing lines in operation.

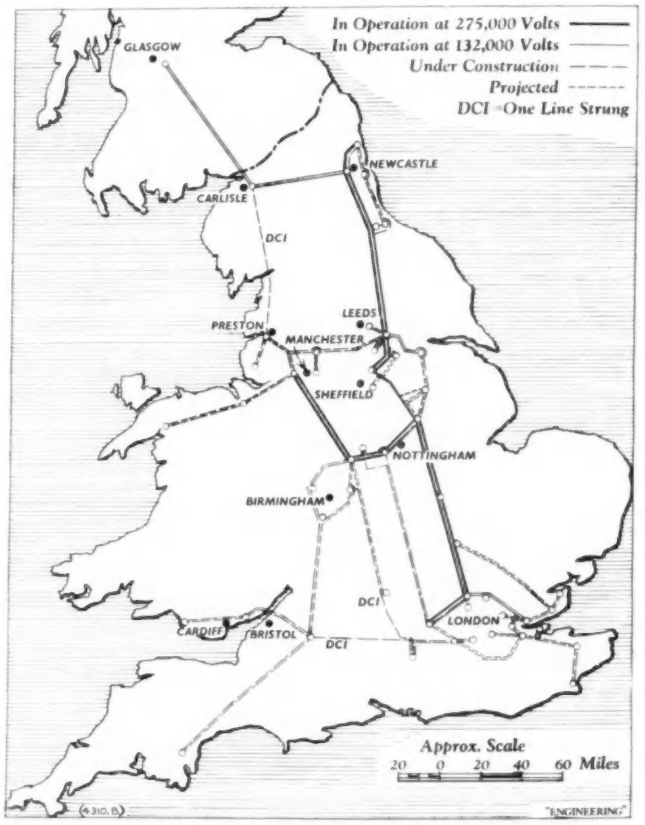


Fig. 2 Proposed position of 275 kV system in 1965 showing lines in operation, under construction and projected.

SOME ECONOMIC RESULTS

Since 1939 the 132 kV grid has been operated as a completely interconnected network. Even before the end of the war, however, it was clear that if expanded at this voltage it would become too complicated to be conducted in this way in order to obtain the necessary economies. In 1950 the maximum demand was about 12,500 MW. It was then decided to develop a plan suitable for an increase of this figure to 30,000 MW during the next 15 to 20 years, and to initiate the construction of a scheme capable of meeting requirements up to 1960. For this purpose a voltage of 275 kV was chosen as being the highest at which lines and equipment could be provided for operation in the atmospheric conditions of the British Isles. The functions of the new system were to pool the generating plant and to facilitate its location near the coal-producing areas so that electricity could be transmitted by overhead lines in preference to the more expensive transport of coal for long distances overland to generating stations sited near the load centres.

Estimates showed that an interconnected pooling system to meet requirements up to 1960 could be provided at a cost of £64 million and, by permitting the reduction of spare generating plant otherwise necessary in the various areas, would reduce the capital expenditure on generation and certain transmission lines by £110 million during the same period. If such an inter-connected system were also to be used for transferring energy economically from generating stations sited on the coalfields to load areas, additional overhead line capacity would be required. This might be provided by using larger conductors than those in the first plan or by additional circuits. The extra cost for this additional provision would be about £8 million, but there would be operational savings rising to £5 million per annum.

LAY-OUT CONDITIONS

The major developing coalfields were those in the Midlands and Yorkshire from which the transport of energy, either as coal or electricity would be necessary to the north-west, south-east and south-west. It was therefore decided to provide 275 kV lines with capacities of 375 MW per circuit from Yorkshire to Scotland, where interconnection was the main consideration, and lines with a capacity of 550 MW per circuit between Yorkshire, the Midlands and the southern part of the country. For the lines from Yorkshire northward twin 0·175 sq. in. conductors were adopted, while for those southward and westward they were to be of 0·4 sq. in. copper equivalent. The cost of the former might have been reduced by using a single 0·45 sq. in. conductor, but twin conductors had advantages in carrying capacity and line reactance. The twin 0·4 sq. in. conductors at 12 in. spacing could be operated at 380 kV without a dangerous increase in corona or interference levels.

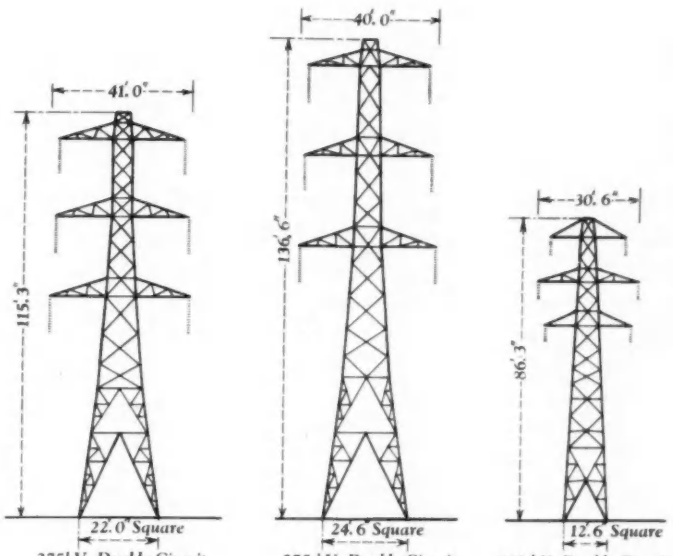
TOWER CONSTRUCTION

The towers are of galvanised steel lattice with concrete block foundations, and the insulators are of the cap-and-pin type, both toughened glass or porcelain, between which there is no technical discrimination, being used. The minimum ground clearance of the conductors for the twin 0·175 sq. in. lines is 23 ft., but this has been increased to 25 ft. where the future operating voltage may be 380 kV. The normal spacing is 1,200 ft. The basic factors controlling design are specified in Government regulations: the basic design of the twin 0·4 sq. in. conductor line includes electrical clearances which are adequate for 380 kV, but provides for an insulator string length which is suitable for 275 kV only. A typical suspension string includes 18 insulators of the "fog" type giving an overall leakage path of 300 in. and a potential leakage path of 180 in. The service period has been too short to admit of much comment. Certain designs of line spacer, however, showed serious signs of fracture even before the lines had been made alive and extensive replacement has been necessary. There were eight lightning faults during 1956, but damage was slight. Radio and television interference was not serious.

A project is under consideration for increasing the working voltage of a line to 380 kV so as to obtain experience at this pressure in varied atmospheric conditions. Typical double-circuit tower outlines are shown in Fig. 3.

TRANSFORMER DESIGN

The 275 kV system is earthed solidly at every transformer neutral, and in view of the ratio of transformation from the 132 kV system there is a capital saving in making use of star-



275kV. Double Circuit Straight Line Tower for Twin 0·175 Sq. In. Conductor

275 kV. Double Circuit Straight Line Tower for Twin 0·4 Sq. In. Conductor (Designed for Future Operation at 380 kV.)

132 kV. Double Circuit Straight Line Tower for 0·175 Sq. In. Conductor

Fig. 3 For several reasons, mainly connected with operations, double circuit lines have been used on the 275 kV supergrid. Two types of tower are shown in outline, one for the northern section and the other for the southern together with an an example for use at 132 kV.

connected auto-transformers with a delta-connected tertiary for harmonic suppression. As the transmission distances are not great, high reactance does not seriously prejudice stability, but assists in restricting the short-circuit duty at the substations. A reactance of 15 per cent. was therefore specified for the 275/132 kV auto-transformers. Double-winding units are necessary as generator transformers and where connection from the 275 kV has to be connected to others with a voltage lower than 132 kV.

All the 275 kV windings have graded insulation and are designed for an impulse withstand level of 1,050 kV peak. The bushings are of the under-oil re-entrant form and include an earth-band 16½ in. long for accommodating the protective current transformer. The main transformers are provided with forced-oil air-blast cooling, but 50 per cent. of the continuous maximum rating is obtainable under natural cooling conditions. They are equipped with on-load voltage regulating equipment with a range of ± 15 per cent. on 132 kV, three methods being used. All the auto-transformers so far made are of the core type and are built from hot-rolled steel with three or five limbs and windings of the disc or multi-layer concentric type. The neutral end of each phase of the main winding is brought out to a separate bushing so that protective current transformers can be installed in each phase of the earthed star point. With the voltage ratio and tapping range specified, either the series or common part of the winding can provide the thermal limit depending on the tapping switch position. "Thermal images" feeding the winding temperature inductors are therefore associated with both parts of the winding, using current transformers mounted on the 275 kV bushing and in the neutral lead, respectively.

Double-wound transformers with a rating of 120 MVA are used to give a bulk supply to 66 kV networks, while the generator transformer ratings so far adopted are 106 MVA, 125 MVA and 210 MVA and are associated with 100 MW, 120 MW and 200 MW machines. The voltage ratio is 13 to 16/295 kV with a tapping range of ± 10 per cent. provided by equipment at the neutral end of the 295 kV winding. The low-voltage windings are connected in delta and the high-voltage windings in star, and oil forced water cooling is standard.

EQUIPMENT STANDARDISATION

The design of the substation structures is based on the requirement that they should not fail in adverse weather conditions until after the associated overhead line supports have also failed. The two types of structure most widely used are of reinforced concrete or of frames formed of bolted galvanised steel angles. The former are slightly cheaper to construct and if properly made involve no maintenance. For these reasons this type has been used throughout for the 275 kV substations. They may be either pre-cast or cast *in situ*, the former method being preferred as it is the cheaper and gives a better finish. The most usual substation layout is of the double busbar pattern.

In spite of serious consideration no progress has been made towards switchgear standardisation. A standard design of two-post isolator with a rating of 7,500 MVA has, however, been produced and is used universally. Interchangeable designs of current and voltage transformers are also being employed. Four different designs of circuit-breaker are at present being used, three being of the air-blast and one of the bulk oil type. The standard short-circuit rating is 7,500 MVA and there are two continuous current ratings—800 amperes and 1,200 amperes. All the 275 kV circuit-breakers have a 1/50 impulse voltage withstand level of 1,050 kV and a one minute frequency withstand level of 485 kV. Details of the construction of these circuit-breakers, all of which comply with British Standard specification No. 116/1952 where applicable are given in the lecture. The total break time of any 275 kV breaker does not exceed 0·1 second on any breaking capacity test duty. They are suitable for the addition of high-speed automatic reclosing facilities with a circuit dead time adjustable down to 0·25 second.

The principal forms of protective equipment include high-speed phase comparison apparatus with an operating time not more than three half cycles for the main feeders, balanced current and Buckholz protection for the transformer feeders, and balanced earth fault protection for the main busbars. Five designs of 275 kV cable are in process of development and testing. They are all about 100 yards long and are laid direct in the ground. Performance has been satisfactory.

Although certain minor difficulties have been experienced, said Mr. Lane, there have been no more than would be expected with equipment on so large a scale not hitherto tried in service. Everything, in fact, points to the successful establishment of a system which will meet the expanding needs of the country in terms of load and generating plant for some years to come, making in the process its own special contribution to the country's general economy and standard of living.

A HANDY PORTABLE STOVE

A portable gas stove which has the flame under the instant control of a tap removes all the inconveniences usually associated with the paraffin stove. Now to be marketed in this country by the Pneumatic Tent Company, Limited, 139-140 South-street, Dorking, Surrey, is the range of butane stoves that has been available for some years in France under their trade name of "Camping Gaz." The larger models, which are suitable for parties of men on expeditions, civil engineering sites, etc., have burners which screw on to heavy containers in which is liquid butane. A variety of sizes is available: there are models with one or two burners for cooking, with a reflector for heating, and also with a mantle and shade as a hurricane or ordinary lamp.

The smallest model, the Bleuet, shown in the illustrations below, has an expendible container of liquid butane in which there is enough fuel for 2½ hours, burning at maximum heat. (In the larger models the container is an initial purchase and is exchanged when empty for a full one after the manner of some existing systems in this country.) The butane container is shown on the left of the lower illustration. It is made from metal pressings and clips on to the bottom of the jet assembly; the latter is then screwed down to pierce the top of the container with a needle that it carries. The flame is controlled by a screw valve on the side. As with the larger lamps, the burner for cooking can be replaced with a gauze and mantle assembly which is enclosed in a globe, to give light approximately equivalent to a 60 watt bulb. The complete stove weighs rather less than 1 lb. and measures 6 in. by 4 in. A polythene carrier is available that will take a stove, spare butane containers and a lamp assembly.

The Bleuet portable stove weighs less than 1 lb. Its expendable container supplies butane to the burner, which can be lit instantly without the need for priming. By fitting a mantle the stove is converted to a portable lamp.

Book Reviews

MUSIC AND PHYSICS

The Electrical Production of Music. By ALAN DOUGLAS. *Macdonald and Company (Publishers), Limited, 16 Maddox-street, London, W.1.* (28*s.*)

Science is based upon facts. Facts are based upon observation. When theorising gets too far ahead of experiment or is even substituted for observation, any branch of science is in danger of landing in cloudcuckooland. Such was the fate of classical musical acoustics. Because of the absolute amount of mechanical energy present in even the loudest sound is so small, measurements had to be based upon resonance. But in any vibrating system, to establish resonance needs time. Therefore experimental work was concentrated upon the " steady state." If the experimental workers had no alternative, the mathematical workers followed the same path because it was much easier. The vibrating system, such as a stretched string or column of air, was idealised, and its equation of motion written. The initial conditions, got by imagination rather than by observation, were set down and the equation solved to give the steady motion of the system after it had settled down to regular, if perhaps complex, vibrations. Such in essence is the work summarised in the classical volumes of Helmholtz and Rayleigh. There is, of course, nothing " wrong " with the mathematics or the experimental observations, but do they tell us much about musical acoustics?

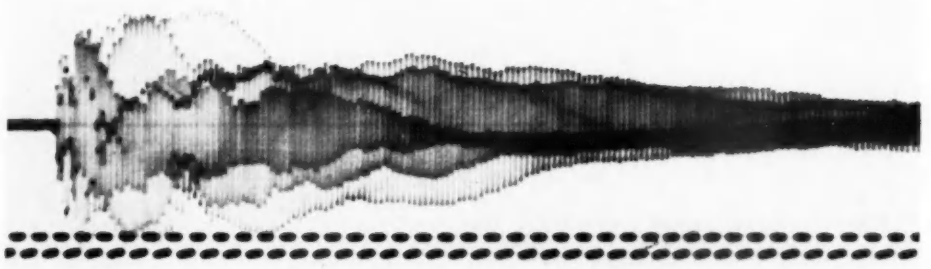
There is no doubt that they tell a great deal about many kinds of steadily sustained notes. Music itself contains many steadily sustained notes. On a modern organ fitted with an efficient electrical blower, a note can be steadily sustained long enough to enable the experimenter to photograph its wave-form as a steady picture on a cathode-ray oscillograph and to make a detailed analysis of its overtone structure by using an electrical wave analyser. But a single note is not music.

A less obvious feature greatly increases the difficulty of that kind of research in musical acoustics which shall be related to what happens in actual music heard as sound. A single note has some characteristics, such as pitch, loudness and tone colour, which are retained when the note occurs with other notes. In addition, new characteristics, such as consonance and dissonance, may appear in note combinations. These new characteristics cannot be seen as inherent in the single notes. They are what might be called pattern-properties—properties of a whole which cannot be seen as inherent in the parts from which the whole is built. Diamond and graphite are both built of the same parts—carbon atoms—yet when the same carbon atoms are put together in different patterns some new characteristics appear in each new combination. In this kind of phenomena, so common in music, order or arrangement is of greater relevance than quantity. Measurement is therefore of little help.

Perhaps the whole difference between classical musical acoustics and the newer approach is that we now adopt the musicians' outlook and regard music as communication between composer, performer and hearer. The greater the " information " content of musical sounds, the farther do they depart from the steady state of classical acoustics, from the single steadily sustained note whose information content in music is exceedingly small.

Electro-acoustics has completely transformed the experimental techniques of acoustics. No longer must the research worker be tied to resonance. In fact great care is often taken to avoid it. Realistic musical acoustics is now completely dependent upon the thermionic valve. By using microphone, amplifiers and tape recording, the ephemeral live sounds to be studied can be taken down and used in evidence, for or against. If the experimenter has second thoughts, his recorded material can be re-examined. By electrical manipulation the recorded sounds can be analysed, not only to give the acoustic spectrum of steady sounds, but also by the use of high pass, low pass and band filters. Most important of all, the results of the filter analyses can be listened to, stage by stage in the analysis.

In a developed science the scientist is not satisfied with analysis alone. When a chemist thinks that he has successfully synthesised as complex a biological compound as one of the vitamins or hormones, he is not satisfied merely with chemical or physical tests. Biological tests must also be applied. In acoustics this involves a task still more difficult than analysis. However, the last twenty years have seen great developments in this work and a detailed account of the techniques is now given in this book.



Displacement-time curve for the sound from a single note played on a concert grand piano in a recording studio. The change of wave form with each cycle of the fundamental period is revealed. The time markings are in one-fiftieths of a second.

The author develops the treatment given in his earlier book, *The Electronic Musical Instrument Manual*, so as to include also a fuller account of the physics of musical instruments and of musical sounds. The second half of the book deals systematically with the electrical generation of oscillations at audio-frequencies and their modification to give great variety of wave form. From the standard definitions of tone-colour (timbre) one would have thought that a synthesist need only copy the acoustic spectrum of the notes of an actual musical instrument, adjust the amplitudes and durations, in order to give a fairly good imitation of music performed on the original instrument. The earliest attempts soon showed that much more was needed to give realism. Ingenious electrical and mechanical devices have had to be designed to control also the rate of growth and decay, vibrato, portamento, glissando and reverberation. Although noise is officially defined as " sound undesired by the recipient," electrical noise has had to be incorporated into all successful electrical synthesisers of musical sounds.

Although the author shows that he is well aware of the great complexity of actual musical sounds, he adopts the usual attitude of scientific writers on electrical synthesis. He frequently refers to " defects " of conventional musical instruments, and to synthesised sounds as " improvements " on normal musical sounds. Another expert in electrical synthesis writes that " the inherent limitations of musical instruments have hampered the work of the composers of music." Musicians who can hear the differences between normal musical sounds and synthesised imitations, or who may not like some of the entirely new sounds which can be generated electrically, are not necessarily prejudiced. Musical instruments, whether traditional or electrical, each have their own acoustical characteristics. No man can say whether a violin is a " better " instrument than a clarinet. An electronic synthesiser, on its own, is as uncreative as an electronic brain—rather like a man who can speak fluently many languages but has nothing of his own to say in any of them. The musical interest of conventional or electronic instruments lies solely in their use by creative artists who will select from the enormous variety of tonal characteristics those best able to express their ideas.

More might have been included on the experiments in progress in Germany, Italy, France and elsewhere on the creative use, by composers, of electrically produced and manipulated sounds of types which cannot be made by normal musical instruments. The use of electrically produced sounds to imitate normal musical sounds is successful only with listeners lacking in the musician's discriminating powers. To try to imitate the change in tone colour with pitch, so characteristic of musical instruments, is exceedingly difficult. To try to imitate the still subtler changes of tone colour with each vibration of the fundamental, as shown in the accompanying illustration of a single note played on a first-rate concert grand piano, in a recording studio, is at present impossible.

No matter how fascinating the musical scientist may find the subject of musical acoustics, he must never forget that music comes first. He still has plenty of food for thought. To attempt to eliminate subjective judgments automatically excludes music and all problems of musical interest. Music is the most highly developed form of abstract art and physics is the most highly developed science. Both are human activities. Each may help the other. For long, science has found measurement a most effective tool, but problems are arising where pattern-properties or *gestalt*-properties are concerned. For those, measurement is an ineffective tool. Music, rich in examples of this type of phenomena, may therefore help in developing an additional attitude of mind useful in science itself.

Any implied criticism of the book on account of these general ideas is controversial; there is no doubt that the new volume is a valuable addition to the literature of a developing branch of musical acoustics. A new edition would be still more welcome if the new kinds of sounds, made available by electrical techniques, were treated as different sounds rather than improved sounds. A fuller account, with discography, of the creative use of these new sounds by composers, would be welcome and would help the reader to hear and judge for himself.

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GEAR HOBBING AND SHAVING

Gear Hobbing and Shaving. By A. SYKES. *David Brown Industries, Limited, Huddersfield, Yorkshire.* (25*s.*)

Hobbing is only one of several gear generating processes, but it is one which has many advantages. Gear shaving has something in common with hobbing, although it is solely a finishing process, and it is possible for the two operations to be carried out on dual-purpose machines.

It is reasonable, therefore, to consider the two processes in a single volume.

The overall picture of gear hobbing which emerges from a study of this book is one of great versatility, coupled with accuracy and long life of both machines and hobs. On the score of versatility the hobbing machine is particularly attractive, since it will deal with spur and helical external gears, worms, wormwheels and splines, and can also, with small modifications, cut internal spur and helical gears. Long life in hobbing machines is a function of two main factors, absence of reciprocating parts which cause wear by reversal of direction of masses, and low rate of movement on the important slides. The hobs themselves run for long periods between re-grinding because they have a large number of cutting edges. Coupled with these features is the fact that machines are built to suit all purposes, from the cutting of large marine and turbine gears to automobile gear production under automatic cycle control. Hobbing has many virtues, but like other processes which give a high degree of accuracy, it demands appropriate attention if it is to maintain its performance.

The initial requirement, accuracy in the machines themselves, is the responsibility of the manufacturer. The machines described in the book, which are all products of the David Brown Machine Tool Division, are built to the appropriate British Standard Specification, but they can only function properly if they are both installed and used correctly. Foundations are of obvious importance, though no hard and fast rules can be given; each installation must be considered in relation to its particular circumstances.

On the question of operation, however, it is possible to be more specific. The supporting of gear blanks during cutting, for example, can have an important effect on both the rate of production and the quality of finish. Similarly, such important features as concentricity of teeth in relation to locating diameter, accuracy of transverse and axial pitches, and tooth thickness, all depend upon correct setting and using procedure. For example, the alignment of the machine heads is set initially when the machine has been running long enough to reach a stable working temperature, and when very high-precision work is being done, a finishing cut should not be taken until similar conditions obtain.

Gear shaving, which reduces minute errors of tooth profile and pitch, and improves the surface finish and tooth contact, can be used for more than one purpose. It can have as its object quieter running and better distribution of tooth pressure, leading to longer life, or alternatively, enabling heavier loads to be carried for a given size of gear. In small and medium-sized work, gear shaving, coupled with attention to material quality and heat treatment, can give quiet running without the necessity for tooth profile grinding. Like hobbing, shaving can be done on either a limited or a quantity production basis; similarly, it is a precision process, and has to be treated as such to get the best results.

The book is published by a manufacturer of gear machines, but it is objective in outlook, and should fulfil the stated intention of being helpful to those who are interested in the subject, but have not had the time to study it in detail. A good index and a selection of illustrations, both line and photographic, are useful features.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Machine Tools. B. ELLIOTT & CO. LTD., Victoria Works, Willesden, London, N.W.10. Details of a range of lathes, shaping, slotting, bench and pillar drilling, grinding and polishing, and sawing machines, together with accessories, including vices, chucks and dividing heads. Illustrated catalogue.

Tube Expanders. SAMUEL OSBORNE & CO. LTD., Clyde Steel Works, Sheffield, 3. Expanders for heat exchanger and condenser tubes. Two series H.E.9 with 1¼ in. rollers and a rolling length from ½ to 1½ in. and H.E.10 with 2¼ in. rollers and a rolling length between 1¼ and 6¾ in. Tube sizes from ½ to 1¼ in. outside diameter. Leaflet.

Heating Manual. SIGMUND PUMPS, LTD., Team Valley, Gateshead 11. Principles of forced-circulation in hot-water heating systems for domestic and small industrial buildings. Illustrated booklet. (Price 3*s.* 6*d.*)

Circulating Pump. SIGMUND PUMPS, LTD., Team Valley, Gateshead, 11. "ThermoPak" pump for forced-circulation hot-water heating systems. Glandless, silent, electrically driven, installed direct with pipeline. Two types, 13 models with deliveries up to 50 g.p.m. against a head of 20 ft. Leaflet No. 1041/4.

Machine Tools. SOAG MACHINE TOOLS, LTD., Juxon-street, Lambeth, London, S.E.11. Details of circular saw and band type cold sawing machines; horizontal, vertical and universal milling machines; and lathes ranging from 8¼ in. to 48½ in. centres. Three illustrated leaflets.

Steel Shuttering. GUYREX EQUIPMENT, LTD., 25 Craven-street, Strand, London, W.C.2. Steel shuttering in standard units for all types of concrete construction; floors and ceilings, as well as walls. Illustrated brochure gives items and applications.

Economic Boilers. STOCKTON CHEMICAL ENGINEERS AND RILEY BOILERS, LTD., Perseverance Works, Stockton-on-Tees. Two and three-pass boilers with capacities from 2,000 to 25,000 lb. per hour; coal or oil burning, stoker or hand firing. Also waste-heat boilers. Booklet.

Colloidal Graphite. ACHESON COLLOIDS, LTD., 18 Pall Mall, London, S.W.1. The nature, manufacture and advantages of colloidal graphite as a lubricant are set out in a pamphlet "Colloidal Graphite—What is it?"

Immersion Heaters. THE THERMAL SYNDICATE, LTD. P.O. Box No. 6, Wallsend, Northumberland. "Vitreosil" de-mountable electric immersion heaters; ratings from 0·25 to 5 kW for use in acid tanks and electroplating baths. Illustrated brochure.

Resistance Welding Control. BRITISH THOMSON-HOUSTON CO. LTD., Rugby. Illustrated booklet covering the equipment and practice of electronic control of resistance welding. Publication No. G13023.

Lightweight Pneumatic Drill. CONSOLIDATED PNEUMATIC TOOL CO. LTD., Dawes-road, London, S.W.6. Details of a ¼ in. capacity pneumatic hand drill, with either a pistol grip or a lever type throttle. Illustrated leaflet.

Platform Truck. ANGEL TRUCK CO. LTD., 215/219 Albion-road, Stoke Newington, London, N.16. "Celtruck" low platform truck, self propelled electric or manual operation. Two sizes, 6/8 and 10/12 cwt. capacity. Leaflet.

Eliminating Smoke. SMOKE BURNERS LTD., 130 Baslow-road, Totley Rise, Sheffield. The Godber smoke burner: apparatus for injecting secondary and tertiary air into a furnace to produce complete combustion. Leaflets.

Splicing Conveyor Belts. BRITISH TYRE AND RUBBER CO. LTD., Herga House, Vincent-square, London, S.W.1. "On-site" splicing of rubber conveyor belts; service is continuously available. Leaflet.

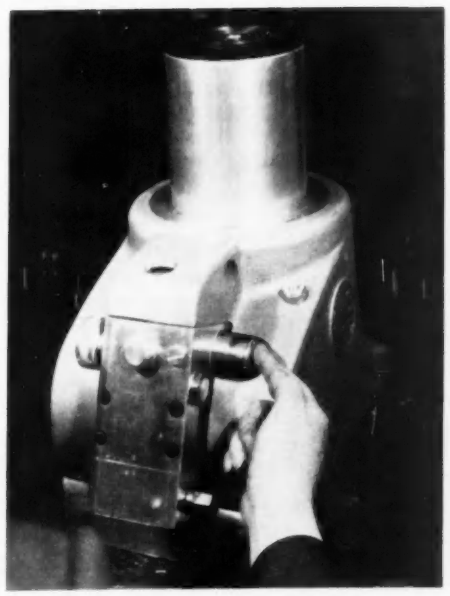
Marking Equipment. STANDWELL EQUIPMENT CO. LTD., Worple-mews, Worple-road, London, S.W.19. Stamps, punches and dial-type nameplate marking machines. Abridged catalogue.

Chain Drives. RENOLDS CHAINS, LTD., Renold House, Wythenshawe, Manchester. Examples of space saving by the use of chain drives. Leaflet.

TWO-SPEED HYDRAULIC HAND PUMP

In designing the latest addition to their "Hydralite" range of hydraulic jacks, a 100 ton model, Tangyes, Limited, Cornwall Works, Smethwick, Birmingham, arranged for it to be powered by a small hand pump of self-contained unit construction, which can be used for any other purpose requiring small quantities of hydraulic fluid at high pressure. It is suitable for operation with either oil or water, being constructed of aluminium alloy and stainless steel.

The pump, as will be seen from the accompanying illustration, which shows it fitted to a 100 ton jack, is of simple rectangular form, which can be bolted to any convenient flat surface. It has two speeds, which are obtained by means of two plungers, the high-pressure one working inside that which provides the low pressure; the changeover from one pressure to the other is effected by a push-button. In the illustration this pressure-selection button is seen being pushed in, which will set the hydraulic circuit for high-pressure operation. A hexagon-ended shaft projection for a detachable handle, a small handwheel controlling the needle-type release valve, and piping connection points complete the external fittings of the pump. There is only one pipe between the pump and the reservoir, this pipe being used for suction and for exhaust when the pressure is released. A removable suction filter is fitted into the circuit. Similarly, there is only one pipe on the pressure side, but there are two pressure-connection points, one at the end and one on the top of the pump. The point which is not in use can either be plugged off, or else a pressure gauge can be connected there if required.



The latest Tangyes "Hydralite" jack—of 100 tons capacity—has a two-speed hand pump, which can be supplied as a separate unit.

The low-pressure plunger operates at a maximum pressure of 750 lb. per sq. in., and delivers 3·1 cub. in. of liquid per stroke. High-pressure plungers can be supplied for pressures of 10,000, 6,500, 4,500, 2,500 or 1,600 lb. per sq. in., and it is a simple matter to change the h.p. capacity of the pump at any time, by removing the two plungers together and substituting a pair which has the high-pressure unit of the required size.

The pump is supplied for three applications: as an integral part of the 100 ton Hydralite jack; as a basic unit without a reservoir, suitable for building into machinery and connecting to a reservoir supplied by the user; and as a self-contained portable unit in a light fabricated framework, complete with reservoir.

When fitted to the 100 ton jack the pump gives a lift of 0·12 in. per stroke of the handle when on low pressure, and 0·01 in. when the high-pressure plunger is in circuit. The jack itself has a closed height of 12½ in., and a lift of 6 in. It can be fitted with a retaining nut if required, when the closed height becomes 14½ in. Like the other jacks in the range, the 100 ton model is made as light as possible by the use of light alloys; it weighs approximately 100 lb., and a lifting hole is provided so that, with the handle inserted, it can easily be carried by two men.

Marketing

A COMPANY'S FRIENDS

The art of keeping in touch is slowly being mastered by British industry. Increasingly companies are beginning to publish news of themselves not only for their workers and staff, but for their customers and suppliers and for those whose money is making possible the company's growth and development. Recent publications of this kind include a most ambitious history of Stewarts and Lloyds' first 50 years. This book, 160 pages long, is a stimulating story of growth—from the time Andrew Stewart in Glasgow and the Lloyd brothers, Samuel and Edward, began independently to make iron and steel tube in Glasgow and Birmingham in 1860 to their amalgamation in 1903. Thereafter the progress of Stewarts and Lloyds is traced for the full 50 years, taking in the two world wars and their considerable impact. Men, machines and products are described and illustrated, and the company very well introduced.

A very different type of publication, the *Perkins News*, has won the prize awarded by the Direct Mail Advertising Association for the fourth time since the war. Published quarterly in colour, it brings to 25,000 customers rather more than the company's products. It is a lively and continuous record of progress which serves admirably to keep in touch with their friends.

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Guidance for the Installer

Domestic central heating is beginning to spread in this country. Air pollution and high fuel costs militate against the open grate. Government departments, fuel research establishments, the oil companies and others all point to central heating as a great improvement. This can now be installed quickly and simply by using small pipes which can be bent round corners, over doorways, etc., to follow whichever lay-out is best suited to the particular heat requirements of each house.

The heart of such a system is a small circulating pump, completely silent and free from vibration. Such pumps have been made on the Continent for many years, but only recently in Britain. The principles of installation are simple enough, in fact much more so than for a gravity system. The problem was how to reach and instruct the many thousands of plumbers and builders who might be called upon to install such systems. Sigmund Pumps Limited attempt to do so by means of a manual, *Principles of Forced Circulation in Hot Water Heating Systems* (3*s.* 6*d.*), which is intended "to bring together for quick reference and easy calculation the necessary data to deal with . . . smaller, straightforward installations." The manual is concise and well produced. It is, in fact, likely to be used by many heating engineers as well as by the plumbers and builders to whom it is directed.

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Credit for the Consumer

A most detailed study of consumer credit in the United States has recently been published by the Federal Reserve Board. It is the most searching inquiry ever made of consumer credit as an economic force and a public issue. A large number of business opinions are quoted in the report, including that of the General Electric Company and of other engineering concerns whose prospects are vitally affected by the availability of consumer credit. The reason for making the inquiry was the fear that consumer credit would tend to accentuate trade cycles, by over-expanding in booms and over-contracting in slumps.

The report gives a most interesting insight into the part played by consumer credit in the growth of the United States engineering industry. Without it there is no doubt that the fantastic rise in car output—over 45 per cent. of the total is for cars—and in the sales of household appliances would not have taken place. In fact United States industry would be substantially smaller than it is to-day.

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Credit for Exporters

The recent announcement that United States manufacturers had secured, in 1956, 700 million dols. more than in 1955 to finance foreign trade is a clear indication of their intentions to compete in world markets despite the dollar shortage. British exporters have not been so fortunate, nor could they hope to be. Nonetheless, there are signs that the Government are aware of the challenge and prepared to do their best to meet it.

The new Exports Credit Guarantees Bill proposes that the aggregate amount of the Board of Trade's liability at any one time should be raised from £150 million to £250 million. This should enable the Exports Credit Department to give greatly increased assistance.

Private insurance has also risen substantially in recent years—a welcome sign that British traders are doing their best to keep up with their customers' needs. But the competition is increasing and the amount demanded could well rise above the country's capacity to finance it.

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No More Seasons for Cars

Reports that steel companies are being asked to increase their deliveries to British motor-car manufacturers have produced renewed criticism of the industry's optimistic attitude. If United States experience is any guide and Detroit's estimates are reliable, there will be a sizeable recovery during the summer and autumn.

One of the unusual facets of United States cars so far this year is the failure of the spring demand to materialise. In the words of a commentator "the seasonal factor in buying seems to have evaporated." Some of the experts say that "automotive technology and the changed pattern of United States culture have outmoded seasonal buying." Cars now tend to be used equally in winter and summer.

Price is assuming greater importance than at any time since the war, and competition is severe. Sales in the first quarter were less this year than last, but a recovery had begun in April and dealers expect output to be about 5 per cent. up on 1956. They are waiting for General Motors' 1958 models to appear this autumn to whip up sales to a new peak.

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Selling Reactors

International competition for nuclear engineering markets is becoming very keen. United States industry, with the full backing of the Government and of the Atomic Energy Commission, is now making a determined bid for the Japanese market. Following recommendations by the Japanese atomic energy delegation to purchase a British-made Calder Hall type of reactor, Admiral Strauss, chairman of A.E.C., has invited the Japanese Minister of State, Mr. Uda, to visit the United States this year. Japan is being pressed to conclude a new atomic power agreement as a first step to the sale of an enriched uranium power reactor.

American manufacturers of nuclear plant have been most active and are taking full advantage of official backing. The Westinghouse Corporation offered an enriched uranium pressurised water reactor of 134 MW capacity for 35 million dols. on the understanding that the Import-Export Bank would advance 80 per cent. of the purchase price, repayable in 25 years. This is tantamount to giving it away and it is no mean tribute that in such circumstances the British design should still be favoured by the Japanese.

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Booming Caravans

The production of caravans continues to rise. Last year it totalled over 14,300, worth nearly £6½ million. This is a 25 per cent. increase over the previous year and demand is still rising. The industry owes much of its progress to the increasing use made of caravans by industry for mobile exhibition purposes. The success of this method of sales promotion was commented upon in these columns in our issue of December 21, 1956, page 789. The latest company to write to us on this subject is Newman Hender and Company, Limited, who have decided to take their exhibition of industrial valves on a Continental tour this spring.

There is little doubt that if its arrival is well announced and followed up by personal calls, the mobile showroom method has advantages over other methods of sales promotion. It is a most interesting development in the technique of personal selling which appears to be particularly suitable for engineering products.

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Capital Goods at Liege

The International Fair at Liege between April 27 and May 12 is likely to show principally the metal and engineering products developed by Britain's competitors. So far, only eight British firms have booked space, compared with 18 last year. Liege is to the International Brussels Fair very much as Birmingham was to London in the case of the B.I.F. Metals, heavy and light engineering and industrial electricity are the main sections, with particular emphasis on mining plant. Last year there were 43 exhibitors from Western Germany and 28 from the United States. Once again German manufacturers are likely to dominate the Fair.

The poor British showing is difficult to understand in view of the great interest shown in the Common Market. Over 80 per cent. of last year's 200,000 visitors to the Liege Fair came from west European countries, and there could be few better opportunities to stake a claim on their interest. It is a sad reflection on the interest the British engineering industry, particularly mining and heavy engineering, has in the markets of western Europe.

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One Voice for Pre-Packagers

The rapid growth of the packaging industry is a feature of post-war industrial development, and the need to organise the industry is becoming urgent. The Association of British Packaging Contractors, formed only eighteen months ago, point out that there are many fields in which co-operative action is beneficial. Discussions with Government departments is one, research and the dissemination of technical information are others. Above all, however, is the adoption of standards and effective co-operation with the British Standards Institution. The Association's comment on "the frustration involved in receiving entirely different specifications from different Ministries for packing identical products" is unlikely to apply to Government departments only. The adoption of internationally acceptable standards is one of the most urgent needs of our export industries. So is research in packaging practice in export markets.

The Association of British Packaging Contractors have a strong case for extending their membership to include not only pre-packaging contractors but also the large numbers of manufacturers of packaging materials and equipment.

ECONOMICAL AIR CONDITIONING

When an office building for W. Oertli A.G. of Zürich was being built, it was decided that a ventilating and air-conditioning plant must be installed. The building is situated close to a main road with heavy traffic, for which cause the windows are preferably kept closed, and behind the office block were workshops which also consistited a source of disturbance. Moreover, for those rooms in which much smoking is done experience had shown that air-extraction plants were required. To avoid certain difficulties which would occur in connection with the relatively small groups into which a main plant would have to be divided and so as to be able to heat and cool the rooms according to the external temperature, a plant with high-speed air conditioning convectors was chosen. This has the great advantage that only a small quantity of air means that the plant required is small both for the conditioning and for the ducting.

The installed plant has been designed so that in winter when the outside air temperature is 5 deg. F. (the average day temperature) a room temperature of 68 deg. F. can be obtained. In summer with outside temperatures of 86 deg. F. and with 40 per cent. relative humidity, the inside temperature is maintained at 79 deg. F. and 50 per cent. humidity, provided that the building is protected against direct solar radiation by the external blinds. The required heat output from the convectors amounts to approximately 400,000 B.Th.U. per hour in winter, while in summer a total of 124,000 B.Th.U. per hour has to be extracted

The air-conditioning plant consists of a central air-treatment plant, distribution ducts, the high-speed convectors, refrigerating plant with compressors and condenser, an oil-fired heating boiler, and circulating pumps, together with the various controls and the piping systems to convey the heated or cooled water to the convectors. The temperature of the primary air treated in the central plant is controlled from a thermostat in the supply air duct, and is kept automatically at the desired optimum by means of a modulating control valve. At the same time, the fresh air is being humidified by a water spray under the control of a humidistat.

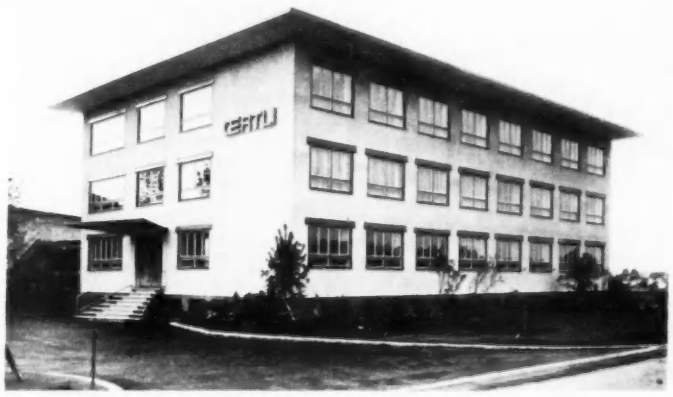


Fig. 1 Air conditioning this office block of many rooms in noisy surroundings and subject to large variations in external temperatures has been achieved by using a high-speed convector system.

Fig. 2 In the built-in convector units, high-speed jets of conditioned air draw large quantities of room air over heat exchangers.

Fig. 3 As the quantity of conditioned air required is small, the ducts can be of small diameter and mounted in the hollow ceilings.

relatively small amount of air has to be handled by the conditioning plant—less than one-fifth of the total required for ventilation in this particular case.

The fresh air which is pre-treated in the central conditioning plant, is distributed under high velocity through a system of ducting to air-conditioning convectors which are built into the window sills of the individual rooms. An example is shown in Fig. 2. The air is discharged through nozzles at high speed, and these act as ejectors so that the stream of air carries with it a large quantity of air from the room. A heater/cooler is built into the equipment so that the room air flowing through it can be heated in winter and cooled in summer. The actual quantity of primary air used is between 1,000 and 1,400 cub. ft. per hour per person. This

In summer, when the boiler is taken out of commission, a three-way valve is set to direct the water flow to a cooler, so that cold water passes through the pipe work. The refrigeration plant is also brought into use to cool both the water and the primary air.

A standard prefabricated fresh-air treatment plant made by Sulzer Brothers Limited, of Winterthur, Switzerland, was used for this installation and was possible on account of the small quantity of primary air involved. Its use dispensed with the need for constructing a brick-built air-conditioning chamber. Interchangeable cell-type filters clean the air, removing over 95 per cent. of the dust. The clean air then passes through the cooler and through the heater. In winter the fresh air is automatically humidified in the spray chamber and any droplets of water are removed by eliminator plates before it enters the distribution ducts. The pipe system involved consists of three sets: first the ducts for the primary air, second the water pipes for the heat exchangers in the convectors, and third the pipes for the draining of water condensing on the surfaces of the heat exchangers. The pipes handling the high-velocity primary air are mounted in the hollow ceilings, as shown in Fig. 3, and are of comparatively small diameter. The air velocities within them are between 2,000 and 3,000 ft. per minute. Cork insulation is used. A centrifugal fan, insulated for noise, delivers the air to the convectors.

Each convector consists of an air-distribution chamber with elongated nozzles for the outlet of the primary air and a heat exchanger in which the secondary air is heated or cooled. The outlet slots are fitted with louvres which can be adjusted as required and allow for suitable air distribution. Plant regulation is carried out by adjusting the temperature of the water used for heating and cooling, or by altering the condition of the primary air as supplied by the central plant. The temperature of the air leaving the convectors can be adjusted by regulating each unit separately.

Outside normal working hours the fresh-air treatment plant is taken out of operation. In winter the heat exchangers in the convectors are sufficient to supply much of the heat required for the various rooms by the normal convection effects. The room temperature will drop slightly below the design temperature when the fresh-air plant is stopped, but due to the low heat storage in the pipes it can be restored very quickly when the plant is re-started. The apparatus has considerable advantages in that it is possible to vary the conditions in each room separately; economies also can be effected by taking out of commission either the air-treatment plant or the refrigerating plant during the times that the office building is not occupied, by the efficient insulation of the pipe system and by the relatively small duty requirements of the fresh-air ventilators.

CERAMIC TOOLS

A Bibliography

Manufacturers of ceramic tools have claimed that such tools are capable of cutting hard metals at operating speeds higher than those of the conventional steel or carbide tools.

A good deal of research has already been conducted on the new cutting media and the results of some investigations have been published. Consequently, the Science and Commerce Department of the Sheffield City Libraries has produced "A Select Bibliography on Ceramic Tools". Copies of the bibliography, which contains 43 references in British, American, Russian and (one) Czech periodicals, may be obtained gratis on application to the City Librarian, Surrey Street, Sheffield, 1.

Looking along the outer vacuum envelope of the new Harwell 50 MeV proton linear accelerator. Protons are injected into the accelerating tube, which is more than 100 ft. long, with energies of 500 keV, and there further accelerated. A special focusing device gives high beam currents.

ATOMIC REVIEW

More than Meets the Eye

SO often has the work of the scientist borne unexpected fruit. However pure he may consider his research, however abstract the results may seem, it is seldom long before a practical use is found for his discoveries. Thus obscure experiments with vacuum tubes and high voltages in the first half of the present century may be responsible for a major feature of the second—atomic power. There is more to research than meets the eye, and money spent on it is seldom wasted. It follows that the revelations of the physicist are likely to prove significant to engineers—even speculative studies concerning the fundamental laws of physics.

Physics

Parity

Whether the hands of a clock move clockwise or anti-clockwise depends on which side of the clock face you are. Similarly, the direction of travel of any point moving on a circle cannot be specified until there is some means of specifying on which side of the plane of motion the observer is standing. These considerations, together with the fact that clockwise motion becomes anti-clockwise on reflection in a mirror lead to the formulation of the parity law. The law states that, for any atomic or nuclear system, no new physical consequence or law should result from the construction of a new system which is a mirror image of the original. In other words, if there should be some other race of intelligent beings who use definitions of left or right-handed screws that are the opposite to ours, the strangers' laws of physics will produce the same results as ours.

Further implications of the parity law may be gathered from the diagram below. Suppose particle 1 is spinning about an axis AA′. Now let a second particle be found—particle 2—which is the mirror image of 1. The parity law states that there should be no observable difference between the two particles, 1 and 2, which may be detected by measurements made along the direction AA′. The law permits predictions. Suppose 1 is radioactive and disintegrates into electrons. The law predicts that equal numbers will be emitted in the directions A and A′. Consider the alternative. If 1 emits more electrons towards A, 2 must emit more towards A′, since 1 becomes identical to 2 merely by turning it upside down. But should this happen, 2 is now no longer the mirror image of 1. The mirror image has the opposite relationship, between spin and direction of radiation, to the original particle, giving a new physical result.

Recently the law of parity has been demonstrated to be false. The experiments that showed this were proposed by two physicists seeking the solution to the problem of the $\theta^+ (\equiv K_{\pi_2}{}^+)$ and $\tau^+ (\equiv K_{\pi_3}{}^+)$ mesons. Recent experiments indicate that the two mesons have closely identical lifetimes and masses; however analysis of the decay products strongly suggest, on the grounds of angular momentum and parity conservation, that θ^+ and τ^+ are not the same particle. A solution to the dilemma was suggested by Mr. T. D. Lee and Mr. C. N. Yang, who postulated that parity was not conserved in weak reactions. They went on to suggest means by which their hypothesis might be tested experimentally.

Previously experiments had shown that parity was conserved in strong and electromagnetic interactions, but for weak interactions (decay interactions for mesons and hyperons, and various Fermi interactions) parity conservation was only an extrapolated hypothesis.

There were two methods by which parity could be checked experimentally. The first was to measure the distribution of electrons emitted during decays of oriented nuclei. The second was to measure the alignment of meson spins in relation to their decay products, which are also electrons. The latter method was applicable to existing photo emulsions and a careful check showed that data confirming that parity was not preserved had been laying on physicists' shelves for some time. The latter method called for difficult technical operations.

The radioactive nucleus cobalt 60 was selected for study. By cooling to 0·01 deg. K, all thermal motions in the material were reduced to extremely small values. The application of a magnetic field causes most of the nuclei—which are known to be spinning—to align themselves like small magnets, parallel to the magnetic field. The radioactive nuclei disintegrate giving off electrons. The crucial point is the comparison of the number of electrons emitted along one direction of the axis of spin with the number emitted in the opposite direction. To count the particles, scintillation counters had to be installed in complex vacuum and cooling equipment and extreme care had to be taken to eliminate spurious effects. An illustration of the equipment is reproduced below. The experiment showed decisively that parity was not conserved.

Violation of the principle of parity implies the existence of a right-left asymmetry within our particular part of the universe. It may be that an overall symmetry exists, that there are two kinds of proton p_R and p_L with opposite

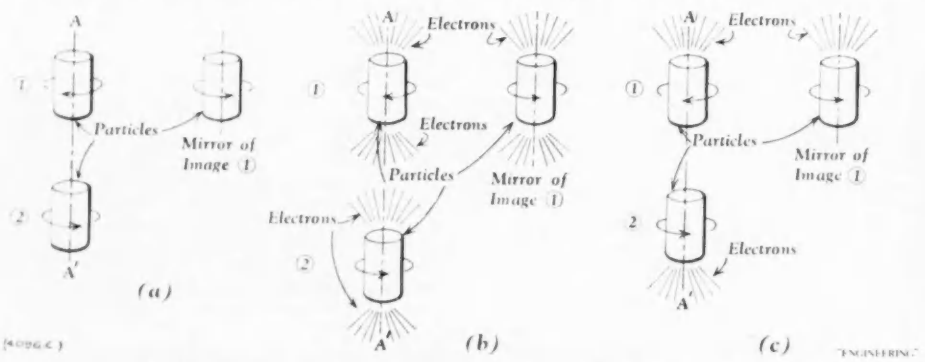
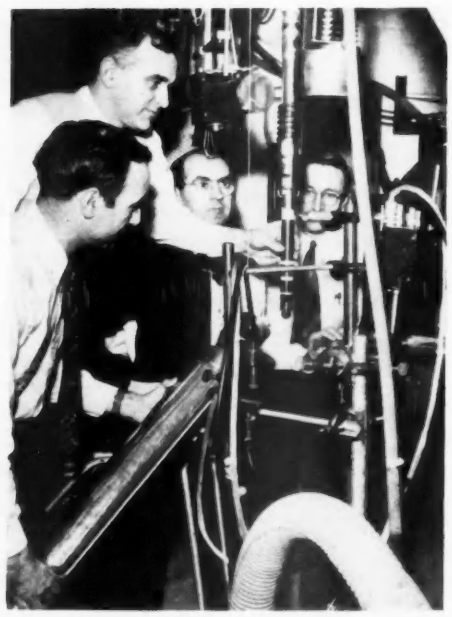


Diagram illustrating concept of parity, which has recently been demonstrated to be false.



Assembly of low-temperature equipment used to cool radioactive cobalt 60 for the parity experiment. The vertical tube (upper right) contains the cobalt, a beta-ray counter and a thermometer.

Inside the accelerator chamber of a 32 MeV proton linear accelerator at the University of California. The protons are accelerated through the drift tubes shown at the centre of the chamber. Some American accelerators will be discussed in a subsequent Atomic Review.

parities. At the present time protons must be of predominantly one kind to give the Fermi-Dirac statistics observed for these particles. Furthermore the free oscillation period between them must be greater than the age of the universe. Thus the right-left asymmetry need not be ascribed to a basic non-invariance under inversion, but to a cosmological local preponderance of, say, p_R over p_L (similar to the local preponderance of the positive proton over the negative anti-proton).

Anti-nucleons

Recent experiments with anti-protons have led to an interesting discovery of which no immediate explanation appears to be forthcoming. The experiments were concerned with the interaction of anti-protons with matter. The particles were fired at a target of an absorbing material and detectors arranged to determine whether the particles were annihilated or scattered. It was discovered that not only are anti-protons attracted to nucleons but that the attraction experienced was immensely stronger than that existing between nucleons. The nucleon in the nucleus is bound by an energy of some 5×10^7eV. An anti-proton of ten times this energy finds that the nucleus has double the cross-section that a proton of similar energy would experience. Thus, whereas it was originally expected that an anti-proton would rapidly be annihilated by collision with a proton, resulting in the emission of high energy mesons, it was found instead that anti-protons are readily absorbed by nuclei.

Quantum Mechanics

Most physicists agree that quantum mechanics is not completely satisfactory but feel that the removal of any discrepancies is largely a matter of mathematical refinement. Recently, in the field of electromagnetic interactions, refinement has met with great success and theory and experiment have been made to agree to an incredible degree of accuracy. However, there have been serious criticisms of the fundamental assumptions of quantum mechanics. It has been suggested that the usual arguments in its favour are tautologous. Various alternatives have been put forward, many involving classical models with hidden variables. Statistical models have been proposed in which randomness arises from hidden variables in much the same way that randomness in the motion of a Brownian particle arises from the discrete impacts of molecules too small to be seen under a microscope. Some theories require a sub-electronic particle—as yet undiscovered, but tentatively compared with the neutrino.

Binding Forces

At present an important field of physical study is that concerned with the forces which bind together the atomic nucleus, and it is thought that valuable information on the nature of these forces may be obtained by bombarding the nucleus with particles accelerated to high energies. It should be emphasised that these particles are not entirely what the word particle implies; in some circumstances it is more useful to think of them as wave motions.

Accelerators

The means by which the bombarding particle is given a high velocity are known as accelerators, and these take various forms, some of which are listed in the table below. The object is to product particles with a high kinetic energy, preferably in excess of 300 MeV, which is the threshold for the formation of mesons, and also to obtain considerable beam intensities, since the more particles available, the greater the probability of a collision occurring. Particle energy and beam intensity are unfortunately to some extent inversely related; the more of one the less of the other, in effect. Another important consideration is the increase of mass with energy in accordance with Einstein's $e = mc^2$ law—a factor which becomes most important at high energies. The most important limiting factor, however, is cost, since these machines are very expensive. Nevertheless, ingenuity in design can often produce similar effects for considerably smaller expenditure; for example, machines requiring much less magnet steel than existing accelerators have been designed to give comparable particle energies. In any case it should be noted that comparatively low-energy machines retain their usefulness, since every energy range has its own associated problems, the study of which may add usefully, though perhaps less spectacularly, to present knowledge.

TABLE.—*Forms of Accelerator*

Van de Graaff Electrostatic Generator.—A machine in which a high potential is produced by the accumulation of electric charge conveyed to an insulated conductor by a continuously moving belt. The potential generated is used for accelerating charged particles.

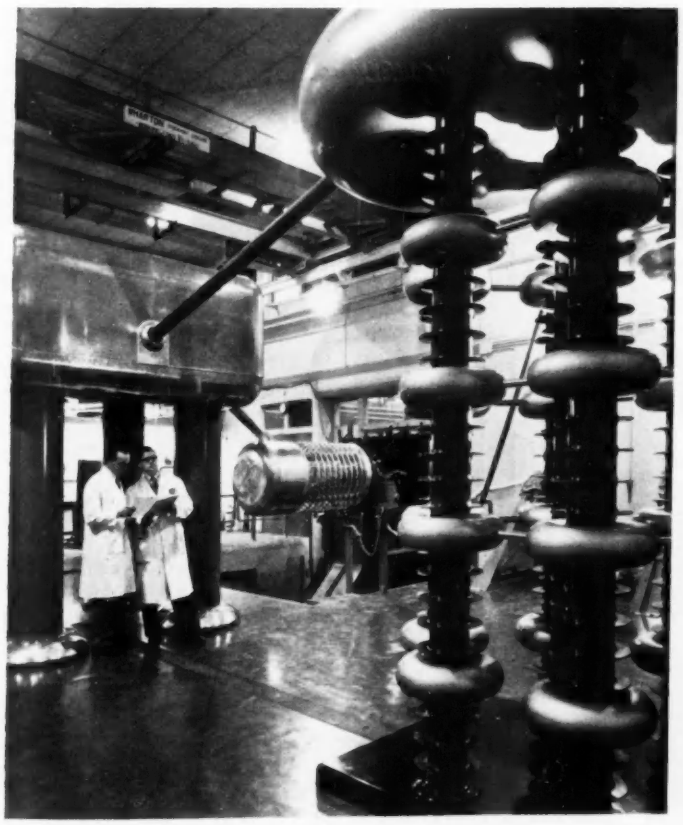
Linear Accelerator.—A machine in which particles are accelerated to high speeds in passing through a straight evacuated tube or waveguide. Acceleration is produced by electromagnetic waves in the tube.

Cyclotron.—A machine that accelerates heavy particles to very high speeds in a spiral path. The particles are held in the spiral by a magnetic field and are accelerated twice in each revolution by an electrostatic field, produced by a radio-frequency oscillator.

Synchro-cyclotron.—A modified or frequency-modulated cyclotron based on the phase stability of orbits—an approach in which use is made of the relativistic $e = mc^2$ effect.

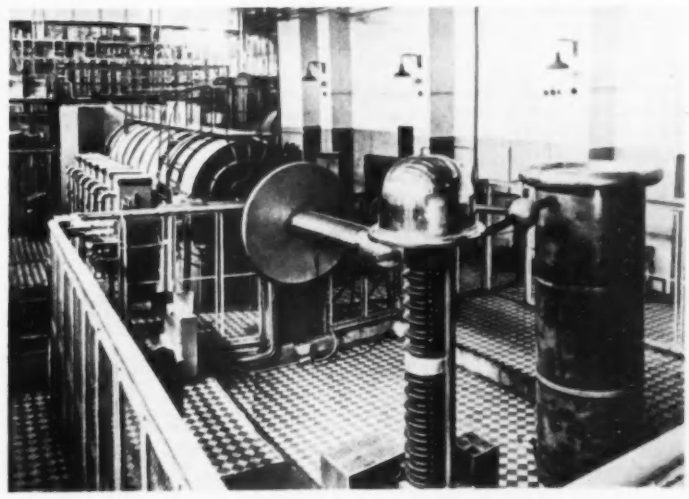
Synchrotron.—A machine for accelerating electrons or protons to high speeds; particles are kept in a circular path by a guiding magnetic field and are accelerated in this path by synchronous electric impulses.

Synchrophasotron.—In the Soviet Union "synchrophasatron" is the name given to an accelerator in which a magnetic field increasing with time is used to control the trajectory of particles; acceleration is effected by an intermittent electric field, the frequency of which also increases with time. In fact it is in principle a proton synchrotron as are the American *Bevatron* and *Cosmotron*.



(Left) Injector end of the 50 MeV proton linear accelerator now being built at Harwell, showing cylindrical ion source (centre background) and Cockcroft-Walton generator (foreground).

(Below) Injector for the proton synchrotron of the U.S.S.R. Academy of Sciences. Reference to Soviet accelerators will be made in a later Atomic Review.



Harwell Projects

It is with these factors in mind that the General Physics Division of the Atomic Energy Research Establishment, Harwell, have undertaken two

new projects. A 50 MeV proton linear accelerator is now nearing completion and the outer vacuum envelope is shown at the top of page 538. The accelerating tube is in three sections totalling more than 100 ft. in length, and over this length the axial alignment is accurate to 0·02 in. An illustration on page 539 shows the injector end of the machine. Protons produced in the cylindrical ion source (centre background) are accelerated by 500 kV pulses from a Cockcroft-Walton generator (foreground). These protons are injected into the first section of the machine and there accelerated to 10 MeV. The second two sections increase the energy to 50 MeV. The second project is a new form of proton synchrotron designed to accelerate protons to 6 to 7 GeV (1 GeV = 10^9 eV), with a beam intensity considerably greater than in existing high-energy machines.

Some abstracts concerning the 6·5 GeV proton synchrotron to be built near Harwell have recently been published. It is novel in that it employs the spiral ridge principle.

In a machine with spiral ridged focusing the frequency of the radial oscillations is almost unaffected by the spiral ridges, whereas the frequency of the vertical oscillations is increased. It is shown that for a field which has the same power law index as the Bevatron, $k = -0{\cdot}6$ ($n = 0{\cdot}6$), the radial oscillations have the same frequency as in the Bevatron and are stable for amplitudes of oscillation of less than 2 ft. whilst the strength of the vertical focusing is increased by a factor 4. This enables the vertical aperture of the Bevatron to be reduced by a factor 3 whilst retaining long injection time. In addition a further saving of stored energy may be possible if saturable pole tips are feasible. The machine considered here has 24 ridges at an angle of 1/12 radian to the circle. The flutter field is ± 25 per cent. and the radial oscillations extend over four radial spiral pitches. (W. Walkinshaw: AERE T/R 2040.)

In order to avoid phase slip, and resonances in radial oscillations, a spiral ridge cyclotron can be operated with frequency modulation. (L. B. Mullett: AERE GP/R 2069.)

Preliminary design parameters for the 6·5 Gev spiral ridge synchrotron have already been obtained. Approximate Lagrangian functions have been derived for studying particle dynamics in spiral ridged fields. In this way the Hamiltonian features of the dynamics are retained while considerable simplification in interpretation has been achieved. The advantages of the machine are weak radial focusing with consequent low momentum compaction, multiple turn injection and transition energy. The vertical focusing on the other hand is increased with a consequent decrease in vertical aperture. (W. Walkinshaw: AERE TP/R 2063.)

Phase stability in cyclotrons with the fixed frequency field law has also been discussed in an Atomic Energy Research Establishment report. Two schemes are considered for obtaining phase stability in spiral ridge cyclotrons without a continuous variation of radio frequency. The first employs an R.F. wave travelling outwards from the centre of the machine, and shows some similarity to a linear accelerator, while the second has a spatial flutter of magnetic field combined with a periodic time variation of radio frequency so as to achieve an "alternating gradient" mode of operation. (L. B. Mullett: AERE GP/R 2071.)

The Nuclear Physics Division at Harwell has also been concerned with work on the concept of parity and in particular with longitudinally polarised beta particle emission as a consequence of the failure of parity conservation in beta decay. It is pointed out that the component of the spin of an electron along its direction of motion is a pseudo-scalar quantity. It is to be expected therefore that beta particles even from an unoriented source should be partially polarised along the direction of emission. Following this suggestion calculations have been made on allowed beta decays of both scalar and tensor types using a parity violating two-component neutrino theory. These show that beta particles emitted in such decays with near relativistic energies should indeed show strong longitudinal polarisation, even when emitted from randomly oriented nuclei, and it is proposed to investigate this polarisation. (P. E. Cavanagh and C. E. Coleman. AERE N/M 80.)

Other notes on accelerators appeared in Atomic Review last year (ENGINEERING, vol. 181, pages 444 and 542, and vol. 182, page 188); and on nuclear fusion last January 25 and January 18, when earlier references to the subject were also listed.

Australian Accelerator

A 4 MeV linear accelerator is now in operation at the Peter McCallum Institute, Australia. The machine was manufactured by Metropolitan-Vickers Electrical Company, Limited.

United States and Soviet accelerators will be discussed in a subsequent Atomic Review.

Fusion

Sir John Cockcroft, speaking in the Boyle Lecture (see Atomic Review, March 22), discussed among other subjects the production of power by the fusion of light elements. Experimental work on heating and containing the hot reacting gas involved in this process was started in the Clarendon Laboratory, Oxford, under Dr. Thonemann in 1948 and a little later at Imperial College under Sir George Thomson. The principle of one method is to heat the gas by a powerful transient electrical discharge from condensers and to constrain the plasma by magnetic fields. Fortunately, by means of the well known pinch effect, the magnetic field of the current itself squeezes the discharge into a narrow filament. This can be helped by superimposed magnetic fields.

Gas Discharge

At the Clarendon Laboratory work also started on discharges in straight tubes but later work, and all work at Harwell, has been concentrated on producing these pinched discharges in toroids since this avoids the use of electrodes, which naturally become very hot.

A paper by Carruthers and Davenport (see Atomic Review, January 25) describes one of the troublesome characteristics of ring discharges. The discharges turn out to have a very powerful instability characterised by wriggling of the discharge in the confining torus. A very simple explanation of this is that if the filament turns itself into a helix the magnetic energy is increased. So it naturally strives to become a helix. Since the magnetic field lines crowd together on the concave side of the curved current channel, there is a greater magnetic pressure there and so the concavity increases. Fortunately there is an opposite effect, predicted also by classical physics, which helps. As the wriggling filament approaches the walls of the tube, eddy currents in the metal tube walls tend to repel the filament. These effects were investigated at Harwell in a glass torus of 10 cm. bore and 30 in. mean diameter, which heated the core by a large pulse transformer. Currents of 1,500 amperes were produced in argon and xenon at pressures of 1 to 5×10^{-3} mm. mercury. The discharges were observed with an electronically gated image convertor which enables photographs of 8 microsec. duration to be taken at any desired moment during the pulsation. The experimental programme consisted of observing the phenomena in such ring discharges; in particular, measuring temperature as a function of current and pressure. Temperatures are measured by classical spectroscopy methods using Döppler broadening to measure ion temperatures. Electron temperatures are measured by microwave techniques. This field of research is a fascinating example of the rapid and recent growth of magneto-hydrodynamics—the interactions between magnetic fields in the motion of matter—which is of importance in stellar phenomena.

Stellarator

The Atomic Energy Commission of the United States has announced that it intends to build a device which it calls a "stellarator." It is to be used for research into thermonuclear fusion and consists essentially of a hollow tube which contains ionised gas. Coils are wound around the tube to produce a magnetic field which contains the gas and isolates it from the walls of the tube. This project represents one of three approaches to the problem which are being made. The stellarator is to be built at the Forrestal research centre at Princeton University, New Jersey. Scientists at Princeton have been engaged on the controlled fusion research programme since 1951.

Probability of Fusion

Physicists calculate that the probability of fusion occurring between hydrogen nuclei is increased by a factor of 10^{23} when a mesic atom is formed by the capture of a meson by a proton. The most favourable reaction is between deuterium and tritium and it is calculated that the catalytic fusion process proceeds rapidly compared with the meson lifetime of $2{\cdot}6 \times 10^{-6}$ sec. However this does not appear to be quick enough. One limiting factor is that 10^{-8} sec. is required to form a molecule; consequently only about 100 reactions could be catalysed within the meson's lifetime. Also in about 1 per cent. of the reactions the meson remains bound to the helium nucleus formed by the reaction. Thus the catalytic chain reaction is broken after only 100 reactions, and insufficient energy is obtained to pay back that required to generate the meson in the first place. A more detailed account of the mesic fusion process appeared in Atomic Review on January 11 and 25.

General Notes

Electro-magnets for Accelerators

Large electro-magnets are a feature of the apparatus used in the study of high-energy particles. What is said to be the largest such magnet constructed entirely of steel castings has recently been installed in University College London by Edgar Allen and Company, Limited. The firm's research and foundry departments co-operated closely with the college physics department in this unique project, and about 25 tons of steel castings have been used. Several smaller electro-magnets for similar studies have also been constructed during the past year.

Naval Reactors

Shut-down of the Submarine Intermediate Reactor (SIR) by the U.S.A.E.C. follows a decision by the United States Department of Defence not to install sodium cooled reactor propulsion systems in any other naval vessel and the completion of experiments to develop operating information required in the sea trials of the submarine Seawolf. Another project has recently been assigned to the Knolls Atomic Power Laboratory, which is operated by the General Electric Company at West Milton, N.Y., to develop a pressurised water nuclear propulsion system for a surface vessel of destroyer class. In addition, the Laboratory is developing a pressurised water power plant, the Submarine Advance Reactor, for the submarine Triton.

Course

It is proposed to hold a familiarisation course in nuclear engineering at Queen Mary College commencing on September 23 1957, and lasting for six weeks. The course which is intended to provide a grounding in nuclear engineering for students of graduate level, will include lectures on nuclear physics, heat transmission reactor theory reactor design the materials of nuclear engineering, fuel technology, and the control, instrumentation and shielding of reactors. A limited amount of experimental work will be included. Further details and application forms may be obtained from Dr. R. F. Saxe, Queen Mary College, Mile End-road, London, E.1. It is requested that application should be made before July 22.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

GLASGOW
Annual General Meeting. Glasgow Branch. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Wed., May 1, 7.30 p.m.

LIVERPOOL
"Electrical Installation in Modern Cargo Vessels," by A. Robertson. Liverpool Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Fri., May 3, 7.30 p.m.

MANCHESTER
Discussion on "Management in Industry." Manchester Branch. Engineers' Club, Albert-square, Manchester. Wed., May 1, 7.30 p.m.

PRESTON
"Emergency Lighting Equipment," by A. S. Wolstenholme. Preston Branch. R.A.F.A. Club, East View, Preston. Wed., May 1, 7.30 p.m.

British Interplanetary Society

LONDON
Films on British and American Rocket Developments. Science Museum Exhibition-road, S.W.7. Sat., May 4, 2.30 p.m. and 6.30 p.m. (Admission by ticket only.)

Building Centre

LONDON
Films on "A Framework of Steel," exhibited by the British Constructional Steelwork Association. Wed., May 1, 12.45 p.m.
Films on "The Control and Eradication of Dry Rot," by Protim Ltd. Wed., May 8, 12.45 p.m.

Chemical Engineering Group

LONDON
"Some New Chemical and Physical Aspects of Polyester Resins Technology," by L. H. Vaughan. Joint Meeting with the Plastics and Polymer Group. The Society of Chemical Industry, 14 Belgrave-square, S.W.1. Tues., May 14, 5.30 p.m.

Chemical Society

LONDON
Centenary Lecture on "Structural Evidence Regarding the Solid Addition-Compounds of Ethers and Amines with Halogens and Other Molecules Acting as Electron Acceptors," by Professor Dr. O. Hassel. Thurs., May 9, 7.30 p.m.

BIRMINGHAM
Repetition of Centenary Lecture, as above. Birmingham Branch. Chemistry Department, The University, Birmingham. Fri., May 10, 4.30 p.m.

DUBLIN
"Organic Semi-Conductors," by Professor D. D. Eley. Irish Republic Branch. University Chemical Laboratory, Trinity College, Dublin. Fri., May 10, 7.45 p.m.

DURHAM
"Chemical Evolution," by Professor J. D. Bernal. Newcastle and Durham Branch. University Science Laboratories, South-road, Durham. Mon., May 13, 5.15 p.m.

Combustion Engineering Association

MANCHESTER
"Comparison of Conventional Space Heating Systems," by J. R. Kell. North Western Section. Engineers' Club, Albert-square, Manchester. Wed., May 1, 10.30 a.m.

Engineers' Guild

EDINBURGH
Annual General Meeting. Edinburgh Centre. Scottish Liberal Club, 109 Princes-street, Edinburgh. Mon. April 29, 6.15 p.m.

LEEDS
Luncheon Meeting. "The Need for More Professional Engineers," by Dr. J. Pearson. Yorkshire Branch. Mansion Hotel, Roundhay Park, Leeds. Mon, May 6, 12.45 for 1 p.m.

Faraday Society

BRISTOL
Bourke Lecture on "Electrokinetic Researches," by Professor A. J. Rutgers (University of Ghent). Chemistry Department, The University, Bristol. Wed., May 8, 5.30 p.m.*

NEWCASTLE-UPON-TYNE
Repetition of the Bourke Lecture, as above. Chemistry Department, King's College, Newcastle-upon-Tyne. Fri., May 10, 5 p.m.*

READING
Repetition of the Bourke Lecture, as above. Chemistry Department, The University, Reading. Thurs., May 9, 4.30 p.m.*

Illuminating Engineering Society

LONDON
Annual General Meeting, at 5.30 p.m. "Changing Tastes in Design," by Paul Reilly, at 6.30 p.m. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., May 14.*

LIVERPOOL
Annual General Meeting. Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Tues., May 14, 6 p.m.

NOTTINGHAM
Annual General Meeting. Nottingham Centre. Electricity Service Centre, Smithy-row, Nottingham. Thurs., May 2, 6 p.m.*

Incorporated Plant Engineers

LONDON
"An Engineer Looks Ahead: Modern Trends in Factory Design and Equipment," by E. C. Stevens. Cromwell Hall, Earl's Court, S.W.5. Mon., April 29, 2 p.m.
"Contemporary Plant Engineering in the United States," by H. M. Sylvester. London Branch. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., May 7, 7 p.m.*

LEEDS
Film Evening, including "Basic Principles of Lubrication." West and East Yorkshire Branch. The University, Leeds. Mon., April 29, 7.30 p.m.

PETERBOROUGH
Various 15-minute papers by members. Peterborough Branch. White Lion Hotel, Church-street, Peterborough. Thurs., May 2, 7.30 p.m.

SOUTHAMPTON
"Liquid Petroleum Gases," by C. F. Port. Southern Branch. Polygon Hotel, Southampton. Wed., May 1, 7.30 p.m.

Institute of Marine Engineers

LONDON
Annual General Meeting. Tues., April 30, 5.30 p.m.*

BRISTOL
Film Evening. West of England Section. Grand Hotel, Bristol. Mon., April 29, 7.30 p.m.

Institute of Metals

LONDON
Spring Meeting, Mon., April 29, to Sat., May 4:
May Lecture on "Education in Science and Technology," by Sir Eric Ashby. Royal Institution, Albemarle-street, W.1. Mon., April 29, 6.30 p.m.
Annual General Meeting, and Presidential Address by Dr. L. B. Pfeil, at 9.30 a.m. Discussion on "The Metal Physics of Corrosion and Oxidation," at 2.30 p.m. Church House, Great Smith-street, S.W.1. Tues., April 30.
Scientific Sessions. Church House, Great Smith-street, S.W.1. Wed., May 1, 9.30 a.m. and 2.30 p.m.
Scientific Sessions. 17 Belgrave-square, S.W.1. Thurs., May 2, 10 a.m.

Institute of Petroleum

LONDON
"The Properties and Use of Bitumen in Road Making"; papers by Dr. A. R. Lee and J. H. Nicholas, and P. C. Leaver. Wed., May 1, 5.30 p.m.*

Institute of Physics

LIVERPOOL
Annual General Meeting. "Rocket Exploration of the Upper Atmosphere," by Professor H. S. W. Massey. Liverpool and North Wales Branch. Department of Electrical Engineering, The University, Liverpool. Fri., May 10, 6.30 p.m.*

Institute of Refrigeration

LONDON
"The Detection of Refrigerant Leaks," by A. C. Murdoch. Junior Institution of Engineers, Pepys House, 14 Rochester-row, S.W.1. Thurs., May 2, 5.30 p.m.*

Institute of Road Transport Engineers

CARDIFF
"Service Methods and Construction of Commercial Vehicles," by C. H. Rowley. South Wales Group. South Wales Institute of Engineers, Park-place, Cardiff. Fri., May 10, 7 p.m.

LIVERPOOL
Annual General Meeting. West Regional Centre. Adelphi Hotel, Lime-street, Liverpool. Thurs., May 2, 7.30 p.m.

NOTTINGHAM
Annual General Meeting. East Midlands Centre. Mechanics' Institute, Nottingham. Tues., April 30, 7.30 p.m.

Institution of Chemical Engineers

LONDON
Annual General Meeting. Presidential Address on "Petroleum and the Chemical Engineer," by John A. Oriel. May Fair Hotel, Berkeley-street, W.1. Tues., April 30, 11 a.m. (Followed by the annual dinner at 7 for 7.30 p.m.)

Institution of Civil Engineers

LONDON
"Water Supply for Doha, Qatar," by Charles Hogg and G. M. Swan. Public Health Division. Tues., May 7, 5.30 p.m.*
James Forrest Lecture on "Large Telescopes," by Dr. R. v.d. R. Woolley. Tues., May 14, 5.30 p.m.*

MANCHESTER
Annual General Meeting. North Western Association. Engineers' Club, Albert-square, Manchester. Thurs., May 2, 6.30 p.m.

NOTTINGHAM
Annual General Meeting. "Some Uses and Advantages of Computing Machines in the Solution of Engineering Problems," by A. C. Stewart. East Midlands Association. Mechanics' Institute, Trinity-square, Nottingham. Mon., April 29, 6.15 p.m.

Institution of Electrical Engineers

LONDON
Informal Evening. Talks on "Radio in Air-Sea Rescue," introduced by G. W. Hosie, D. Kerr and W. Kiryluk. Radio and Telecommunication Section. Mon., April 29, 5.30 p.m.*
Discussion on "The Co-ordination of Education and Practical Training in Sandwich Courses," opened by C. Grad and A. Draper. Education Discussion Circle. Mon., May 6, 6 p.m.*
"Invention and Nature," by F. W. Meredith. Measurement and Control Section. Tues., May 7, 5.30 p.m.*
"The World's Copper Resources," by H. J. Miller. Utilization Section. Thurs., May 9, 5.30 p.m.*

BIRMINGHAM
Discussion on "The Influence of Maintenance Requirements on the Design of Industrial Electrical Equipment," opened by H. C. Fox and J. H. Harris. South Midland Centre. James Watt Memorial Institute, Great Charles-street, Birmingham. Mon., May 6, 6 p.m.*

LEEDS
Annual General Meeting. North Midland Centre. Offices of the Yorkshire Electricity Division, 1 Whitehall-road, Leeds. Tues., May 7, 6.30 p.m.

MANCHESTER
Annual General Meeting. "Lighting for the Amateur Stage," by F. Day. North Western Centre. Engineers' Club, Albert-square, Manchester. Tues., May 7, 6.15 p.m.

Institution of Heating and Ventilating Engineers

GLASGOW
Annual General Meeting. "Air Conditioning in the British Isles," by J. C. Knight. Scottish Branch. Scottish Building Centre, 425 Sauchiehall-street, Glasgow, C.2. Tues., April 30, 7 p.m.

Institution of Mechanical Engineers

LONDON
"Influence of Dynamical Imperfection on the Vibration of Rotating Discs," by Dr. S. A. Tobias and Dr. R. N. Arnold; and "Free Undamped Non-Linear Vibrations of Imperfect Circular Discs," by Dr. S. A. Tobias. Meeting in conjunction with the Applied Mechanics Group. Fri., May 3, 6 p.m.*
James Clayton Lecture on "Projection Planetarium and Shell Construction," by Professor Walther Bauersfeld. Fri., May 10, 6 p.m.*

CARDIFF
Selected Graduate Papers. South Wales Branch. South Wales Institute of Engineers, Park-place, Cardiff. Tues., April 30, 6 p.m.

COVENTRY
Repetition of James Clayton Lecture on "Mechanical Breathing Machines," by Captain G. T. Smith-Clarke. Midland Branch. St. Mary's Hall, Coventry. Thurs., May 16, 6.30 p.m.

NEWCASTLE-UPON-TYNE
Thomas Hawksley Lecture on "Some Engineering Problems in the Industrial Development of Nuclear Power," by Sir Claude D. Gibb. North Eastern Branch. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., April 29, 6 p.m.

Institution of Production Engineers

LONDON
"The Development and Application of Hard Metals," by R. N. Cooke. London Graduate Section. Tues., April 30, 7.15 p.m.

MANCHESTER
"Human Relations in Industry," by J. H. Brebner. North Western Region. College of Science and Technology, Manchester. Mon., April 29, 6.30 p.m.

Institution of Structural Engineers

CARDIFF
"Wind Stresses on Buildings," by H. Ferrington. South Wales Institute of Engineers, Park-place, Cardiff. Tues., April 30, 6.30 p.m.

Junior Institution of Engineers

BIRMINGHAM
Film Evening. Joint Meeting with Festiniog Railway Society. "Festiniog Railway Progress Report." James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., May 1, 7 p.m.

MANCHESTER
Repetition of Presidential Address on "Fuel Economy and Heat-Electric Generation," by Bryan Donkin. North Western Section. Engineers' Club, Albert-square, Manchester. Tues., April 30, 7.30 p.m.

SHEFFIELD
Repetition of Presidential Address on "Fuel Economy and Heat-Electric Generation," by Bryan Donkin. Sheffield Section. Royal Victoria Hotel, Sheffield. Mon., April 29, 7.30 p.m.

Physical Society

LONDON
"Protective Coatings for Thin Films," by Mr. L. Holland. Optical Group. Imperial College, Imperial Institute-road, S.W.7. Thurs., May 2, 2.30 p.m.
"Cyclotron Resonance in Metals," by Dr. R. G. Chambers. Low Temperature Group. Royal School of Mines, Prince Consort-road, S.W.7. Thurs., May 2, 4 p.m.

Plastics Institute

LONDON
"Thermoplastics in the Submarine-Cable Industry," by Sir John Dean. Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Tues., April 30, 6.30 p.m.

Royal Aeronautical Society

LONDON
"The Purpose and Problems of Research Aircraft," by F. P. Youens. Tues., April 30, 7 p.m.

Royal Institution

LONDON
"Urban Improvements of the Nineteenth and Twentieth Centuries," by Sir William Holford. Fri., May 3, 9 p.m.

Royal Society

LONDON
Discussion on "Geophysical Investigations on the Floor of the Atlantic Ocean in Discovery II, 1956." Thurs., May 2, 3 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Interplanetary Society, 12 Bessborough-gardens, London, S.W.1. (TATe Gallery 9371.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Engineering Group, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Combustion Engineering Association, 6 Duke-street, St. James's, London, S.W.1. (WHItehall 5536.)
Engineers' Guild, 78 Buckingham-gate, London, S.W.1. (ABBey 7315.)
Faraday Society, 6 Gray's Inn-square, London, W.C.1. (CHAncery 8101.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. (Solihull 1111.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave-square, London, S.W.1. (BELgravia 3291.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Physics, 47 Belgrave-square, London, S.W.1. (SLOane 9806.)
Institute of Refrigeration, New Bridge Street House, New Bridge-street, London, E.C.4. (CENtral 4694.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of Chemical Engineers, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Physical Society, 1 Lowther-gardens, South Kensington, London, S.W.7. (KENsington 0048.)
Plastics Institute, 6 Mandeville-place, London, W.1. (WELbeck 5439.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list, arranged chronologically, appears in the last issue of each month. Events appearing for the first time, and alterations of dates, places, etc., are indicated by an asterisk (*). Particulars of exhibitions and conferences not included below may have appeared in ENGINEERING, *February* 22, *page* 254; *or March* 29, *page* 414. *Organisers are invited to send to the Editor particulars of coming events as soon as arrangements are made.*

Properties of Materials at High Rates of Strain, Conference on.—Tues., April 30, to Thurs., May 2, in London. Organised by the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1, in collaboration with the Institution's Applied Mechanics Group. Apply to the secretary of the Institution at the above address. Tel. WHItehall 7476.

Health Congress.—Tues., April 30, to Fri., May 3, at Folkestone. Organised by the Royal Society of Health, 90 Buckingham Palace-road, London, S.W.1. Tel. SLOane 5134.

Office Equipment Exhibition.—In May, at Tokyo. Organised by the Japan Office Management Association, 2/1 Ginzanishi, Chuo-ku, Tokyo.

Metallurgical Aspects of the Control of Quality in Non-Ferrous Castings, All-Day Symposium.—Wed., May 1, at Church House, Great Smith-street, London, S.W.1. Organised by the Institute of Metals, 17 Belgrave-square, London, S.W.1. (Tel. BELgravia 3291); and the Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. Tel. Blackfriars 6178.

Valencia International Samples Fair, 35th.—Wed., May 1, to Mon., May 20, at Valencia. Apply to Feria Muestrario International de Valencia, Llano del Real 2, Valencia.

Planning for Industry: Scottish Conference.—Fri., May 3, to Sun., May 5, at Gleneagles. Organised by the British Institute of Management, 8 Hill-street, London, W.1. Tel. GROsvenor 6000.

Caribbean Exhibition.—Fri., May 3, to Sun., May 19, at Port of Spain, Trinidad. Apply to the Junior Chamber of Commerce of Trinidad, Port of Spain, Trinidad.

Home Building Exposition, Second International.—Sat., May 4, to Sun., May 12, in the Coliseum, New York. Exposition offices: 250 West 57th-street, New York 19, U.S.A.

Lille International Fair.—Sat., May 4, to Sun., May 19, at Lille. *Agents:* Weigel, Leygonie and Co., Ltd., 31-32 Kingstreet, London, W.C.2. Tel. TEMple Bar 4825.

Japan International Trade Fair.—Sun., May 5, to Sun., May 19, at Harumi Pier Grounds, Harumicho, Chuo-ku, Japan. Apply to Fair Management Office, Tokyo International Trade Fair Commission, c/o Economic Bureau, Tokyo Metropolitan Government, Marunouchi 3-Chome, Chiyoda-ku, Tokyo, Japan.

Industrial Tool and Production Show of Canada.—Mon., May 6, to Fri., May 10, in the Industry Building, Exhibition Park, Toronto. Apply to Mr. E. M. Wilcox, 19 Melinda-street, Toronto, Canada. (Alteration of dates).

Engineered Castings Show, First; and the 61st A.F.S. Castings Congress.—Mon., May 6, to Fri., May 10, at Cincinnati Music Hall, Cincinnati, Ohio, U.S.A. Sponsored by the American Foundrymen's Society, Golf and Wolf-roads, Des Plaines, Illinois, U.S.A.

British Industries Fair.—Mon., May 6, to Fri., May 17, in the B.I.F. Buildings, Castle Bromwich, Birmingham. Organised and controlled by the Birmingham Chamber of Commerce. Apply to the organisers: P.O. Box 6, 95 New-street, Birmingham 2. Tel. Midland 5021.

Spring Show and Industries Fair.—Tues., May 7, to Sat., May 11, in Dublin. Organised by the Royal Dublin Society, Ballsbridge, Dublin.

Instruments, Electronics and Automation Exhibition, First.—Tues., May 7, to Fri., May 17, at Olympia, London, W.14. Promoted by the British Electrical and Allied Manufacturers' Association and four other trade associations. Organised by Industrial Exhibitions, Ltd., 9 Argyll-street, London, W.1. Tel. GERrard 1622. (Change of address of organisers.)

Standards, Third Conference of Engineers Responsible for.—Thurs., May 9, at Church House, Great Smith-street, London, S.W.1. Organised by the British Standards Institution, 2 Park-street, London, W.1. Tel. MAYfair 9000.

Midwest Automotive Trade Show.—Thurs., May 9, to Sun., May 12, in the Kiel Auditorium, St. Louis. Organised by the Midwest Automotive Trade Show, Inc., 2841 Locust-street, St. Louis 3, Missouri, U.S.A.

Tractor Show, International.—Sun., May 12, to Sun., May 19, in the Exhibition Building, Valentino Park, Turin, Italy. Organised by the Saloni Internazionale della Technica. Apply to the Agricultural Engineers Association, 6 Buckingham-gate, London, S.W.1. Tel. TATe Gallery 7973.

***Construction Surveyors Institute, 31st Annual Conference.**—Mon., May 13, to Wed., May 15, at the Hotel Washington, Washington, D.C. Discussion on "Means for Improving the Efficiency and Economy of Constructional Practices." Organised by the Construction Surveyors Institute, 101 Park-avenue, New York 17, U.S.A.

Office Machinery Exposition.—Mon., May 13, to Thurs., May 16, at Los Angeles, California. Organised by the National Office Management Association, 132 West Chelten-avenue, Philadelphia 44, Penn., U.S.A.

Protective Clothing and Safety Equipment Exhibition, First.—Mon., May 13, to Fri., May 17, at Olympia, London, W.14. Organised by the U.T.P. Exhibitions Ltd. (Associate company of United Trade Press Ltd.), 9 Gough-square, Fleet-street, London, E.C.4. Tel. FLEet Street 3172.

Packaging Exhibition.—Tues., May 14, to Tues., May 21, in the R.A.I. Building, Amsterdam. Organised by N.V. 't Raedthuys, 5 Tesselschadestraat, Amsterdam, Holland.

***Plant Engineer's Adaptability to Change, Conference.**—Wed., May 15, to Fri., May 17, at the Palace Hotel, Buxton. Being the tenth annual conference of the Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. Tel. Solihull 1111.

German Handicrafts and Trade Fair, International.—Wed., May 15, to Sun., May 26, at Munich. Organised by Verein fur Handwerks-Ausstellungen und Messen e. V., Theresienhöhe 14, Munich 12, Germany.

Aluminium in Electrical Engineering, Symposium.—Thurs. and Fri., May 16 and 17, at the Institution of Electrical Engineers, Savoy-place, London, W.C.2. Organised by the Aluminium Development Association, 33 Grosvenor-street, London, W.1. Tel. MAYfair 7501.

Society of Naval Architects and Marine Engineers, Spring Meeting.—Thurs., May 16, to Sat., May 18, at Lafayette Hotel, Long Beach, California, U.S.A. Headquarters of the Society: 74 Trinity-place, New York 6, U.S.A.

Swiss Import Exhibition.—Fri., May 17, to Sun., May 26, in the Hallenstadion, Zürich. Organised by the Schweizerische Import-Ausstellung 1957, Nordstrasse 20, Zürich, Switzerland.

Electronics Exhibition, 12th.—Sat., May 18, to Wed., May 22, in the Palais d'Egmont, Brussels. Organised by the Union Professionnelle des Fabricants et Importateurs de Materiel pour l'Industrie Electronique, 85 Boulevard Emile Jacqmain, Brussels.

Swedish Industries Fair, 40th.—Sat., May 18, to Sun., May 26, at Gothenburg. *Agents:* John E. Buck & Co., 47 Brewer-street, Piccadilly, London, W.1. Tel. GERrard 7576.

Pressure Die Casting Conference, International.—Mon., May 20, to Fri., May 24, in Paris. Apply to the Zinc Development Association, 34 Berkeley-square, London, W.1. Tel. GROsvenor 6636.

Yorkshire Building Trade and Public Works Exhibition.—Tues., May 21, to Sat., June 1, at Woodhouse Moor Exhibition Site, Leeds. Organised by Modern Exhibition Services Ltd., 12 Finghall-road, Urmston, Manchester. Tel. Urmston 3993.

***Royal Ulster Agricultural Show, 90th.**—Wed., May 22 to Sat., May 25, at the Society's Showgrounds, Balmoral, Belfast. Society's offices: The King's Hall, Balmoral, Belfast.

Scottish Radio and Television Exhibition.—Wed., May 22, to Sat., June 1, at the Kelvin Hall, Glasgow. Organised by the Radio Industry Council, 59 Russell-square, W.C.1. Tel. MUSeum 6901.

***Planetary Atmospheres and Convection in Rotating Fluids, Joint Symposia.**—Thurs. and Fri., May 23 and 24, at the Royal Astronomical Society's apartments, Burlington House, Piccadilly, London, W.1. (Tel. REGent 4582.) Organised jointly by that Society and the Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. Tel. KENsington 0730.

Aeronautical Exhibition, 22nd International.—Fri., May 24, to Sun., June 2, at Le Bourget, Paris. Organised by the Union Syndicale des Industries Aeronautiques, 4 Rue Galilee, Paris, 16e.

Mediterranean Fair, 12th.—Fri., May 24, to Mon., June 10, at Palermo. Apply to the Fiera del Mediterraneo, Piazza Generale Cascino, Palermo.

Luxembourg International Fair, Ninth.—Sat., May 25, to Sun., June 9, at Luxembourg. *Agents:* Auger and Turner Group Ltd., 40 Gerrard-street, London, W.1. Tel. GERrard 6671.

***Paris International Trade Fair, 47th.**—Sat., May 25, to Mon., June 10, in Paris. *Agent:* Mrs. M. Hyde-Joucla, 14-15 Rugby Chambers, Rugby-street, London, W.C.1. Tel. CHAncery 6794.

Book Exhibition, Second International.—Sun., May 26, to Thurs., May 30, at Sherman Hotel, Chicago. *Agent:* Mr. A. P. Wales, Dudley House, 36–38 Southampton-street, London, W.C.2. Tel. TEMple Bar 8947.

Chambers of Commerce of the Commonwealth and British Empire, 19th Congress.—Week beginning Mon., May 27, at the Hall of the Worshipful Company of Fishmongers, London, E.C.4. Organised by the Federation of Commonwealth and British Empire Chambers of Commerce, 69 Cannon-street, London, E.C.4. Tel. CITy 4444.

Heating, Ventilation and Air Conditioning, Conference on.—Mon., May 27, to Wed., May 29, at the Fédération Nationale du Bâtiment, 7 Rue La Pérouse, Paris. Organised by the Institut Technique du Bâtiment et des Travaux Publics, 6 Rue Paul-Valéry, Paris, 16e.

African Regional Road Congress.—Mon., May 27, to Thurs., May 30, at Salisbury, Southern Rhodesia. Organised by Road Federations of East, Central and South Africa, with the co-operation of the London office of the International Road Federation, Abbey House, Victoria-street London, S.W.1. Tel. ABBey 6177.

Scaling-up of Chemical Plant and Processes, Symposium.—Tues. and Wed., May 28 and 29, at Church House, Westminster, London, S.W.1. Organised jointly by Het Koninklijk Instituut van Ingenieurs, De Koninklijke Nederlandse Chemische Vereniging, the Society of Chemical Industry (Chemical Engineering Group), and the Institution of Chemical Engineers. Apply to the Institution of Chemical Engineers, 16 Belgrave-square, London, S.W.1. Tel. BELgravia 3647.

***Clothing Trade Fair, First International.**—Tues., May 28, to Sat., June 1, in the Empire Hall, Olympia, London, W.14. Organised by U.T.P. Exhibitions, Ltd., 9 Gough-square, Fleet-street, London, E.C.4. Tel. FLEet Street 3172.

Waikato Agricultural Winter Show.—Tues., May 28 to Tues., June 4, in Hamilton, New Zealand. Apply to Mr. W. H. Paul, Box 616, Hamilton, New Zealand.

Bath and West Agricultural Show.—Wed., May 29, to Sat., June 1, at Swindon. Organised by the Bath and West and Southern Counties Society, 3 Pierrepont-street, Bath. Tel. Bath 3010.

***Padua International Fair and Packaging Salon.**—Wed., May 29, to Thurs., June 13, at Padua. *Agents:* Auger and Turner Group Ltd., 40 Gerrard-street, London, W.1. Tel. GERrard 6671.

Printing Industries and Allied Trades, International Exhibition.—Sat., June 1, to Sun, June 16, in Lausanne. Offices: 6 Avenue Mon-Repos, Lausanne, Switzerland.

***Barcelona Samples Fair, 25th International.**—Sat., June 1, to Thurs., June 20, at Barcelona. Apply to the Spanish Tourist Service, 4 West Halkin-street, Belgrave-square, London, S.W.1. Tel. SLOane 6124.

World Power Conference Sectional Meeting.—Wed., June 5, to Tues., June 11, followed by study tours. Trade Unions' Building, Belgrade, Yugoslavia. Apply to the British National Committee, 201 Grand Buildings, Trafalgar-square, London W.C.2. Tel. WHItehall 3966.

Technical Writers' Institute, Convention.—Mon., June 10, to Fri., June 14, at the Rennsselaer Polytechnic Institute, Troy, New York, U.S.A. Organised as an aid to the profession of technical writing. Apply to Mr. Jay R. Gould, Director, at the above address.

Three Counties Agricultural Show.—Tues., June 11, to Thurs., June 13, at Hartpury, Gloucester. Organised by the Three Counties Agricultural Society, Berrington House, 2 St. Nicholas-street, Hereford. Tel. Hereford 3969.

Safety and Factory Efficiency Exhibition.—Fri., June 14, to Fri., June 21, at Bingley Hall, Birmingham. Organised by Birmingham and District Industrial Safety Group, Industrial Safety Training Centre, 22 Summer-road, Birmingham 27.

***Bordeaux International Trade Fair, 36th.**—Sun. June 16, to Mon., July 1, at Bordeaux. *Agents:* Auger and Turner Group Ltd., 40 Gerrard-street, London, W.1. Tel. GERrard 6671.

Atomic Energy Exhibition, International.—Sun., June 16, to Sat., Aug. 31, at Schiphol Airport, near Amsterdam, Holland. Organised with the support of the Dutch Government, the Amsterdam City Council, and the Amsterdam Chamber of Commerce. Secretariat offices: 37 Roemer Visscherstraat, Amsterdam. *Agents:* Galitzine and Partners Ltd., 17 Victoria-street, London, S.W.1. Tel. ABBey 4013.

Electrical Power Convention Exhibition.—Mon., June 17, to Fri., June 21, at Devonshire Park, Eastbourne. Organised by the British Electrical Development Association, 2 Savoy-hill, London, W.C.2. Tel. TEMple Bar 9434.

Internal Combustion Engine Congress, Fourth International.—Mon., June 17, to Sat., June 22, at Zürich. Theme: "Supercharged Diesel Engines and Combustion Turbines in Various Spheres—Marine, Traction and in Power Stations." Apply to Mr. C. C. M. Logan, secretary, British National Committee, 6 Grafton-street, London, W.1. Tel. HYDe Park 5107. See ENGINEERING, December 2, 1955, page 753.

***Royal Highland Agricultural Show.**—Tues., June 18, to Fri., June 21, at Dundee. Organised by the Royal Highland and Agricultural Society of Scotland, 8 Eglington-crescent, Edinburgh 12. Tel. Edinburgh Central 6106.

***Trieste International Trade Fair.**—Sun., June 23, to Mon., July 8, at Trieste. Apply to the Italian Chamber of Commerce for Great Britain and the Commonwealth, 652 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 5521.

***Institution of Naval Architects, Summer Meeting.**—Tues., July 9, to Thurs., July 11, in Bristol. Organised by the Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. Tel. SLOane 4622.

***Building Plant Exhibition.**—Mon., July 15, to Sat., July 20, at Heaton Park, Manchester. Organised by the Ministry of Works, Lambeth Bridge House, London, S.E.1. Tel. RELiance 7611.

***Skane (Swedish National) Fair, 39th.**—Sat., July 27, to Sun., Aug. 4, at Malmo. Organised by the Skanemassan Kommissariat, Stora Nygatan 15, Malmo, Sweden.

Atoms Exhibition.—In August, at Geneva. Address of organising committee: 1 Place du Lac, Geneva, Switzerland. See ENGINEERING, December 16, 1955, page 816.

Soil Mechanics and Foundation Engineering, International Society of: Fourth International Conference.—Mon., Aug. 12, to Sat., Aug. 24, in London. Apply to the Society's secretary, Mr. A. Banister, Institution of Civil Engineers, Great George-street, London, S.W.1. Tel. WHItehall 4577.

Motor Industry Eleventh Annual Summer School.—Sat., Aug. 24, to Sat., Aug. 31, at St. Catherine's College, Cambridge. Organised by the Institute of the Motor Industry, 40 Queen's-gate, London, S.W.7. Tel. WEStern 0915.

Radio Show, National.—Wed., Aug. 28, to Sat., Sept. 7, at Earl's Court, London, S.W.5. Organised by the Radio Industry Council, 59 Russell-square, London, W.C.1. Tel. MUSeum 6901.

Engineering, Marine, Welding and Nuclear Energy Exhibition.—Thurs., Aug. 29, to Thurs., Sept. 12, at Olympia, London, W.14. Organised by F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 0568.

***Czechoslovak Engineering Exhibition.**—Sun., Sept. 1, to Sun., Sept. 22, at Brno, Czechoslovakia. Organised by the Chamber of Commerce of Czechoslovakia, Rjna 13, Prague. Information obtainable from the Czechoslovak Commercial Attaché, 6 Upper Belgrave-street, London, S.W.1. (Tel. SLOane 0691); and the British Council for the Promotion of International Trade, 15 Hanover-square, London, W.1. Tel. MAYfair 0073.

Farnborough Flying Display and Exhibition.—Mon., Sept. 2, to Sun., Sept. 8, at Farnborough, Hampshire. Open to the public on Fri., Sat. and Sun., Sept. 6, 7 and 8, only. Organised by the Society of British Aircraft Constructors Ltd., 29 King-street, London, S.W.1. Tel. TRAfalgar 3231.

Utrecht International Trade Fairs.—*Autumn Fair:* Tues., Sept. 3, to Thurs., Sept. 12, at the Croeselaan Site, Utrecht. *Agent:* Mr. W. Friedhoff, 10 Gloucester-place, London, W.1. Tel. WELbeck 9971.

British Association Meeting.—Wed., Sept. 4, to Wed., Sept. 11, in Dublin. Apply to the secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1. Tel. REGent 2109.

British Trade Fair and Exhibition.—Fri., Sept. 6, to Sun., Sept. 22, in Helsinki, Finland. Sponsored by the Federation of British Industries, the London Chamber of Commerce and the Finnish-British Trade Association. Supported by the Governments of Finland and the United Kingdom. Organised by British Overseas Fairs Ltd., 21 Tothill-street, London, S.W.1. Tel. WHItehall 6711.

***Radio Isotopes in Scientific Research, International Conference.**—Mon., Sept. 9, to Fri., Sept. 20, in Paris. Organised by the United Nations Educational, Scientific and Cultural Organisation. Apply to the United Kingdom National Commission for Unesco, Ministry of Education, Curzon-street, London, W.1. Tel. MAYfair 9400.

***Food, Cookery and Catering Trades Exhibition.**—Tues., Sept. 10, to Sat., Sept. 21, at the City Hall, Deansgate, Manchester. Organised by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester. Tel. Deansgate 6363.

***Watch and Jewellery Trade Fair, Third International.**—Thurs., Sept. 19, to Wed., Sept. 25, at the Royal Albert Hall, London, S.W.7. Organised by Trade Fairs and Promotions Ltd., Drury House, Russell-street, London, W.C.2. Tel. TEMple Bar 3422.

***High Vacuum Technology, Fourth Annual Symposium.**—Wed., Oct. 9, to Fri., Oct. 11, at the Hotel Somerset, Boston, Mass., U.S.A. Organised by the Committee on Vacuum Techniques, Box 1282, Boston 9, Mass., U.S.A.

Engineering Industries Association; 10th London Regional Display.—Wed., Oct. 9, to Fri., Oct. 11, at the Royal Horticultural Society's New Hall, Greycoat-street, London, S.W.1. Apply to the secretary of the Society, 9 Seymour-street, London, W.1. Tel. WELbeck 2241.

***Coal Preparation, Second Symposium on.**—Mon., Oct. 21, to Fri., Oct. 25, at The University, Leeds. Organised by the Coal Preparation Plant Association (P.O. Box 121), 301 Gossop-road, Sheffield 10. Tel. Sheffield 63031.

In Parliament

MORE DEFERMENTS FOR YOUNG CRAFTSMEN

A statement about the latest Government policy in respect to the deferment of the calling-up of young craftsmen for military service was made in the House of Commons last week by Mr. Iain Macleod, the Minister of Labour and National Service. He informed Mr. Frank Allaun (Labour) that it had been decided to extend the deferment of calling-up for the purposes of study or training, within the framework of the present policy, to cover certain classes of young men who have not hitherto been eligible.

The men concerned would be apprentices, pupils, learners and students coming within the undermentioned five categories. First, men who claimed to be apprentices or learners, who were not covered by existing generally recognised schemes of apprenticeship or training; secondly, men who were being trained as technicians; thirdly, students taking part-time courses of study; fourthly, craft apprentices who have completed their apprenticeships; and, fifthly, students taking full-time courses of study.

With respect to the last-mentioned class, facilities exist for granting deferments to attend full-time courses at universities, university colleges, agricultural and technical colleges, and certain other institutions of further education. There are also arrangements under which deferments are at present allowed for full-time courses of a lower standard which can be regarded as appropriate to the career a man proposes to follow. It is now proposed to extend these arrangements to cover students in full-time attendance at other approved courses, provided that such courses can be completed by the end of the academic year, ending July 31, in which the student concerned reaches the age of 20 years.

Men training as technicians would comprise workpeople who, on the completion of their training, would be qualified by specialist technical education and practical training to work under the general direction of a technologist. Deferments would be granted on the basis that the practical training on the job was combined with part-time study for an approved examination.

It would be an over-riding condition in all these concessions, Mr. Macleod emphasised, that the course of study or training must, as at present, have been entered into sufficiently early to establish the *bona fides* of the application for deferment.

INDUSTRIAL CONTRACTS FOR DEFENCE

Replying to a question by Miss Elaine Burton (Labour), who asked for a statement from the Minister of Defence as to what proportion of this country's defence requirements would be met by industry, Mr. Duncan Sandys said that almost all these requirements would be met in that way.

Miss Burton stated that, as the Minister knew, Sir W. G. Armstrong Whitworth (Aircraft), Limited, Coventry, had been told that skilled men were to be turned away owing to cuts in the defence programme. As there was little prospect of these men being absorbed in existing production work in Coventry, would Mr. Sandys, in accordance with his very recent statement about the skill of technicians becoming an appreciable addition to the strength of this country's economy, state what alternative contracts would be sent to the town. The original question, Mr. Sandys pointed out, referred to the country as a whole and it had not occurred to him that Miss Burton would wish to raise the subject of Coventry. He suggested that she should put down another question if she desired information about Coventry in particular. It did not mean that, because a defence contract was cut, the Government had to find some other form of expenditure to take its place.

Mr. Frank Beswick (Labour/Co-operative) said that Mr. Sandys had previously stated that all sides of the House would be prepared to agree to some compensation being granted to officers who were found to be redundant. There was a good deal of uncertainty and unsettlement among workpeople throughout industry, especially among skilled men, about their future. On this point, Mr. Sandys said that information about the general position would be given shortly by Mr. Iain Macleod, the Minister of Labour. At the same time, in view of the present state of industry, he did not think that there was going to be much difficulty in finding alternative employment; except, perhaps, in very rare cases, for men with special skills.

SAFEGUARDING ATOMIC MATERIALS

The scope of the system of control to be operated by the International Atomic Energy Agency for the purpose of preventing the diversion of fissile materials to the manufacture of nuclear weapons is set out at some length in Article XII of the Agency's Statute, entitled "Agency Safeguards." Mr. Ian Harvey, Joint Under-Secretary of State for Foreign Affairs, told the House that it would be for the Agency to work out the method of applying these safeguards once it had been set up, by agreement between its members. In reply to Mr. P. J. Noel-Baker (Labour), who raised this matter and who had suggested that an explanatory memorandum should be issued, Mr. Harvey said that Article XII, when read in conjunction with Article III, was self-explanatory. He did not think that there was much that could usefully be added in any covering memorandum at the present stage.

It was pointed out by Mr. Noel-Baker that control might be the only means of preventing every nation throughout the world from making its own nuclear weapons, and he pressed for a fuller explanation of the "extremely obscure" Article XII, in order that people might understand what was intended. Mr. Harvey said that there was the 18-Power Preparatory Commission which had been set up, and of which the British Government was a member, working on these proposals for control. The matter was well in hand.

CHARGES AT WELSH PORTS

The recent meeting held by the Ministry of Transport and Civil Aviation to investigate the apportionment of dock charges at the South Wales ports was referred to by Mr. James Callaghan (Labour). He asked to be informed of the results of the discussions and was told by Mr. Harold Watkinson that there had been a full exchange of views. The Industrial Association of Wales and Monmouthshire had asked that shipowners should assume responsibility for certain of the port charges at these ports. The British Liner Committee undertook to inform the shipping lines concerned of the views which had been expressed by the Association. At the same time, the Committee made it clear that it could not commit the lines to any course of action and that the Association itself would later have to pursue the matter directly with the shipping lines and conferences concerned.

WORKERS' PRODUCTIVITY INCREASES

The upward trend of workpeople's productivity during recent years was referred to by Mr. Derick Heathcoat Amory, Minister of Agriculture, Fisheries and Food, in an answer to Mr. Anthony Hurd (Conservative). Mr. Hurd had asked how much labour productivity in agriculture, in terms of net output from the land, had increased during the last 20 years, compared with the labour productivity of urban industry generally.

Mr. Amory said that official estimates of changes in labour productivity were not available for as long a period as 20 years. Over the past eight years, however, industrial output per man was estimated to have increased, on the average, by about 3 per cent. per annum. There were no strictly comparable figures available for agriculture, but, said the Minister, he was satisfied that the increase in the productivity of the man-power in that industry had been at least as fast.

DIESEL SERVICES IN RURAL AREAS

Mr. Watkinson told Mr. W. M. F. Vane (Conservative) that, since his statement on the transport situation on April 24 last year, British Railways had introduced a number of new Diesel services, and that the installation of many more such services was planned. In addition, the British Transport Commission was ordering 22 lightweight Diesel rail buses, for delivery in 1957 and 1958, for experimental use in rural areas in the Eastern, London Midland, Scottish, and Western Regions. During recent months, of course, bus services generally had been slightly affected by the rationing restrictions, but since the beginning of this month, bus operators had been receiving their normal supplies of fuel. He hoped that the book *Village Bus*, which the Ministry of Transport had published last autumn, would assist rural communities to solve their traffic problems.

Shipowners' Liabilities

A request was made by Mr. S. Knox Cunningham (Ulster Unionist) for information regarding the prospects of an international conference to consider the 1955 draft convention relating to the limitation of owners' liability in respect of sea-going vessels. Mr. Watkinson said that the British Embassy in Brussels had been informed officially by the Belgian Ministry of Foreign Affairs that the Belgian Government intended to organise such a conference in October next. The formal invitations were awaited.

Empire's Natural Resources

Among members successful in the ballot for notices of motion on April 17 was Mr. J. A. Langford-Holt (Conservative). He told the House that, on May 3, he would call attention to the need to increase the integration and development of the natural resources of the British Commonwealth and Empire.

Building an Airport at Nairobi

Replying to Mr. A. Fenner Brockway (Labour), who asked about the cost of building an airport at Nairobi, Mr. Alan Lennox-Boyd, the Secretary of State for the Colonies, said that it was now estimated that the new airport which is under construction at Embakasi, near Nairobi, will cost £2,433,000. The airport will be primarily a civil airport, but it will also be available for use by the Royal Air Force if required.

Radiation Hazards at Sea

Information was asked for by Mr. Hector Hughes (Labour) as to what progress had been made by the United Nations Scientific Committee, on which the British Government is represented, in their survey of radiation hazards in ocean waters. He was informed by Mr. Dennis Vosper, Minister of Health, replying on behalf of the Earl of Home, Lord President of the Council, that this Committee is now in session. He understood that the committee was considering the contamination of ocean waters and fish by the deposition of radioactive wastes, but he did not know when its conclusions on this subject would be available.

Starting the Forth Bridge

Major Sir William Anstruther Gray, Bt., (Conservative) invited the Secretary of State for Scotland to say what the first sign visible to the public would be that the building of the Forth road bridge was under way; and when that sign would appear. Mr. John Maclay said he was advised that the first work on the bridge itself would be the construction of the suspension chain anchorages and the piers. It was hoped that the construction of the bridge would be begun in the summer of next year. When another member referred to Sir William's "doubting Thomas" attitude, Mr. Maclay said he was quite certain that Sir William was no doubting Thomas, but an enthusiast.

THE HUMAN ELEMENT

Bridge of Discontent

The current trouble in the engineering unions made contact with the railway unions last week when negotiations broke down between the British Transport Commission and the representatives of the railway shopmen. The B.T.C. offered the men a 5 per cent. increase, which was the rise given to the N.U.M., and extended to A.S.L.E.F. recently. The representatives turned down the offer since conditions about improving productivity were attached to it. This attitude comes from the Confederation of Shipbuilding and Engineering unions to which most of the shopmen are affiliated. A Communist A.E.U. leader headed the negotiating committee.

The shopmen have thus adopted a similar attitude to the footplatemen though for somewhat different reasons. More to the point is that the current trouble in the engineering industry has now spilled over psychologically if not in concrete terms to the railways. The inter-union rivalry on rail is due for a further test at any moment over the negotiations between the B.T.C. and the unions about manning Diesel locomotives. The N.U.R. are thought to be more favourably inclined to avoid "featherbedding" than A.S.L.E.F. on this issue. It is an awkward situation for all parties concerned.

Aviation Medicine

The stresses and hazards of high speed at high altitude—the criterion by which we measure the performance of our aircraft—have given scientists a new uncharted territory to explore. The study of physiological problems—as complex or even more so than those of the heat barrier—is engaging the attention of scientists in all parts of the world. The fifth Congress of Aviation Medicine, which met in Naples, tackled the problem of telling the public something of the effects of flight on the human frame, using words and pictures which would be both interesting and intelligible without losing any essential scientific accuracy.

The result is a startling one and quite delightful. The Italians took a hand and their rich humanity and sense of art served the cause admirably. The progress of science in Aviation Medicine was depicted, by a pilot who is a member of the Centre for Study and Research in Aviation Medicine in Rome, by means of a series of twenty impressionist paintings. Some of these are reproduced in the March issue of *Air*, published by British Petroleum. The artist, Capt. Soldatini, based his paintings on the book *Men in Flight* which explains in simple terms the physiological effects encountered by present-day airmen.

The paintings were the outstanding success of the Congress. They are a most striking and expressive interpretation, by a man who has personally experienced the stresses of fast flight, of the scientific knowledge so far accumulated. It is a unique example of far-sighted public relations by men in the back-room. So few of them, atomic scientists included, realise that the public—ignorant and apathetic as they may be—must be told and made to hear not only the promise but also the dangers of the progress of science.

Fire in the Factory

A number of recent expensive fires, expensive in some cases in human life as well as in property, have resulted in an effort to tighten up fire precaution measures in working establishments. In the last week over 65,000 factories have received a letter from the Chief Inspector of Factories enclosing a leaflet about fire drill. This is part of an effort of the Ministry of Labour to improve the standard of fire precautions in the factory.

The leaflet stresses the need for a plan to be worked out for use when a fire occurs and for that plan to be practised. This is one of those affairs which rest completely on the management for their success. No one is going to become excited or even efficient about fire precautions unless there is attention paid to the subject by the higher management. Although a drill is imperative to cope with fire when it occurs there is little prospect of sustained practice even on a modest scale if there is not drive from the top. There might be some point in addressing a letter to the men at the top in more personal terms rather than leaving the future of the drive in the hands of a modest green pamphlet and the middle rungs of the management ladder.

A European Education

One more type of intra-European organisation is about to receive official recognition. This is the European school at Luxembourg which was recognised for educational purposes by the six member-nations of the Coal and Steel Community last week. Once it is formally approved by the States themselves the statute will give recognition to a school which came into existence in 1953 as a result of a need for the education of the children of the Community's officials. The secondary school qualification envisaged will give a certificate in all respects the same as that ruling in each of the member nations and it will be the first educational standard to cut across national barriers in Europe.

At present the school has 370 pupils from nine nations divided into nursery, primary and secondary sections. A high council will be set up to run the establishment and to appoint a director who will in effect be the headmaster. An administrative council and an inspectorate will ensure the necessary academic standards. It is a laudable idea but the educational overheads per head of population in Luxembourg must now be quite heavy.

Latin for the Engineer

A bold counter-attack is being made on those who would have Latin crowded out of the school curriculum by scientific or "practical" subjects. The Classical Association's new leaflet puts to parents, in the form of questions and answers, the case for Latin in the Middle school. There are few new arguments, but enough to impress the average parent that mathematics, physics and chemistry are not the kernel of a full life nor Meccano or electric train sets the only worthwhile hobbies.

Apart from its impact on the outlook of the child in his early teens—a broadening as well as a sharpening of the mind—Latin can do much to provide the budding scientists with a useful basis for modern languages including their own, and some considerable assistance towards the understanding of technical terms. Professor J. B. Skemp, who spoke at the Classical Association's annual dinner, urged that more Latin should be taught. Proposals to re-educate scientists and technologists in the liberal arts later in life were not, he argued, nearly as satisfactory as a longer training in "drama," which ought to include the teaching of Latin up to ordinary level at least. Thereafter it could be dropped and the students freed to become little specialists.

There is a case for teaching Latin and Greek even beyond ordinary level. One of the drawbacks of our scientific education is that it is only part education. Too many first-class engineers lack the ability to express themselves in good English, particularly in writing. Too many also fail to come to grips with the human content of their job, which, despite mechanisation and automatic controls is becoming even more important and more essential to managers whether in the laboratory or the workshop. Oxford and Cambridge insist on Latin, though with rather less determination than heretofore, and yet produce first-class engineers. More universities and technical colleges could follow their example.

Clubs are Trumps

There is no knowing how or why an idea catches on. The Jones Crane Drivers Club was started some time ago by the United Kingdom distributors of Jones Cranes which are a product of George Cohen Sons and Company and in its first year the membership has passed one thousand. What started as a shrewd selling idea has developed into an organisation with an impetus of its own.

The aims of the club are to foster among crane drivers greater interest and pride in their jobs, to encourage the flow of new ideas and to provide opportunities for members to meet crane drivers in other concerns. Those who thought up the idea must be delighted with the solid, favourably disposed, phalanx of Jones crane drivers which is now building up.

Another club of a similar kind is the Perkins Drivers' Club. The club—for drivers and operators of all types of Perkins Diesel engines—was formed to cover the vehicle, agricultural, industrial and marine fields, and has more than 20,000 members all over Britain. An advantage of club membership is a free £100 insurance payable in the event of a member being killed or suffering total disablement while driving, operating, or servicing any unit powered by a Perkins Diesel engine. Other privileges include a club newspaper, a club badge, training facilities at the Perkins service school at Peterborough, factory visits, social evenings, film shows, and use of an information bureau.

Such clubs bring a new element into technical selling. From now on the salesman has to sell to a management which may have a club within its organisation at shop-floor level dedicated to the maintainance of a particular product in the works. Here is a new kind of organised labour and it could yet present a new kind of problem in industry.

An Englishman's Home

It was to be expected that it would only be a question of time before the new Clean Air Act came between the public and what some of them consider to be their rights to do what they want in, and with, their own grates. West Bromwich Corporation has become the first local authority to issue a smoke control order under the Act and has accordingly received the congratulations of the Ministry of Housing.

The enthusiasm of the Ministry of Housing for this pioneer effort at West Bromwich is not shared by all the ratepayers. The council has been sent a large number of petitions by residents in the area concerned. The order, according to them, violates one of the fundamental liberties of the individual, namely, the right to manage his domestic affairs according to circumstances and inclination. It is clear to the petitioners that the right to send smoke up the chimney is as sacred as the right to stand in front of the fire and keep it off other people—another inalienable right of Englishmen.

The authorities must have thought of this one a long time ago. Householders will be expected to bear only three-tenths of the conversion costs of the fires, the rest being borne by the Exchequer and the local authority—meaning of course the ratepayer and taxpayer and hence the householder in the end.